

U. S. TREASURY DEPARTMENT

HENRY MORGENTHAU, JR., *Secretary*

U. S. PUBLIC HEALTH SERVICE

THOMAS PARRAN, *Surgeon General*

THE RAT  
AND RATPROOF CONSTRUCTION  
OF BUILDINGS

With Specifications, Drawings, and Photographs  
and A Model Ratproofing Ordinance

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## UNITED STATES PUBLIC HEALTH SERVICE

THOMAS PARRAN, *Surgeon General*

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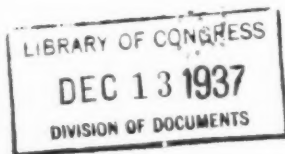
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By B. E. HOLSENDORF, *Passed Assistant Pharmacist*, with drawings by P. W. CLARK, *Senior Naval Architect, United States Public Health Service*

## The Rat

### AN EXPENSIVE AND DANGEROUS PEST

The rat is not only the least useful but is perhaps one of the most dangerous and expensive of nature's parasitic animals living at man's expense (1). "Public Enemy No. 1" among animal pests, to employ a popular phrase, might be correctly applied to the rat, for he stands convicted of the crimes committed by those enemies of society of the more desperate type to which this epithet has been applied.

According to the most eminent authorities (2), rats kill large numbers of young domestic fowls and birds and steal almost anything edible. They are vandals which destroy valuable articles of merchandise. They even commit arson, causing fires by gnawing the insulation off electric wires under floors or in partition walls, and building nests of oily cotton waste or other inflammable material. They are also instrumental in taking human life through harboring parasites which transmit disease.

It is estimated that in any given community the rat population equals that of human inhabitants. Rats are very prolific, producing an average of five litters annually, of from six to nine rats each.

The cost of feeding a rat is generally estimated at one-half cent per day, or nearly \$2 per annum. Assuming that the number of rats in the United States equals that of the human population (3), the cost of feeding these dangerous pests amounts to approximately \$250,000,000 per annum. As the value of material destroyed or damaged by rats in addition to what they actually eat (4) is estimated to be 10 times this amount, we find that the annual cost of maintaining our normal rat population reaches the staggering sum of \$2,500,000,000.

Whether or not this fact is generally known and appreciated by the majority of people, the economic losses are shared by almost everybody the world over; and the hand of man has been raised in all lands against the rat and almost every known means has been employed to

reduce his numbers or to exterminate him. Usually the interest in rat control of the average citizen becomes aroused only when he is either annoyed by the presence of rats or has sustained economic losses due to their depredations. This temporary interest expresses itself in the periodic drives and trapping and poisoning campaigns which are carried out from time to time. Generally, after the immediate danger has passed, such activities are concluded and no further efforts are made to exterminate the rat until conditions again become unbearable.

The economic losses resulting from the destruction of foodstuffs and other commodities by rats and the annoyance which their presence causes are in themselves of sufficient importance to focus the attention of the majority of the population on the need for remedial action. But when it is considered that, in addition, there is a grave public health problem involved, the importance and the magnitude of the task of permanent control of rat life, both on land and sea, can be better understood and appreciated. It should be remembered that it is permanent control rather than periodic reduction of the rat population (7, 8) that will confer the highest degree of health protection and reduction of economic losses.

The problem is an international as well as a national one, as it concerns the general public of all countries (5, 6). It can be solved only by continued and persistent efforts in carrying out measures which are known to produce permanent results, so that freedom from rat life will be the normal state of affairs.

Rats are agents in disseminating certain epidemic diseases through the medium of the parasites that infect them. Bubonic plague has been transmitted to many parts of the world in this manner. In recent years it has been demonstrated that typhus fever also is transmitted by this means (11, 12, 13). Rats are frequently infected with intestinal parasites, especially tape worm. *Trichina* is also found in rats, and these rodents are probably a factor in transmitting the infection among hogs, whence it may spread to man (1).

#### SOLUTION OF THE RAT PROBLEM

Because of this bearing on public health which the presence of a large rodent population in any community has, the health official, whether municipal, county, State, or national, is confronted with an ever present problem, as well as with a responsibility which cannot be evaded.

How to meet it intelligently and practically is a matter of interest and grave concern. The fact that we still have the rat with us in practically every community is evidence that the problem has not been solved in a satisfactory manner. This is probably due to several causes: Lack of understanding of the fundamental factors involved

and as a consequence, absence of a comprehensive or constructive program; lack of funds to carry out such a program even though one has been planned; lack of interest on the part of the public; and lack of cooperation in the carrying out of measures deemed necessary for securing permanent results.

Even when "drives" and "exterminating campaigns" have been started, either as private or community projects, and have attained some measure of success, the tendency is to become less vigilant and persistent as soon as the emergency appears to have passed. The public must squarely face the situation and must understand that there can be no relaxation of effort and that the warfare must be waged continually along the lines indicated if permanent freedom from rat infestation of buildings is to be obtained.

The first step in the solution of the problem of rat control, therefore, is to become acquainted with all of the factors involved and to understand their relation to one another and the fundamental part each plays in the perpetuation of rat life.

#### SPECIES OF RATS IN THE UNITED STATES

The first factor is the rat. No campaign of rat control can successfully be carried out unless the persons engaged in its direction have a general knowledge of

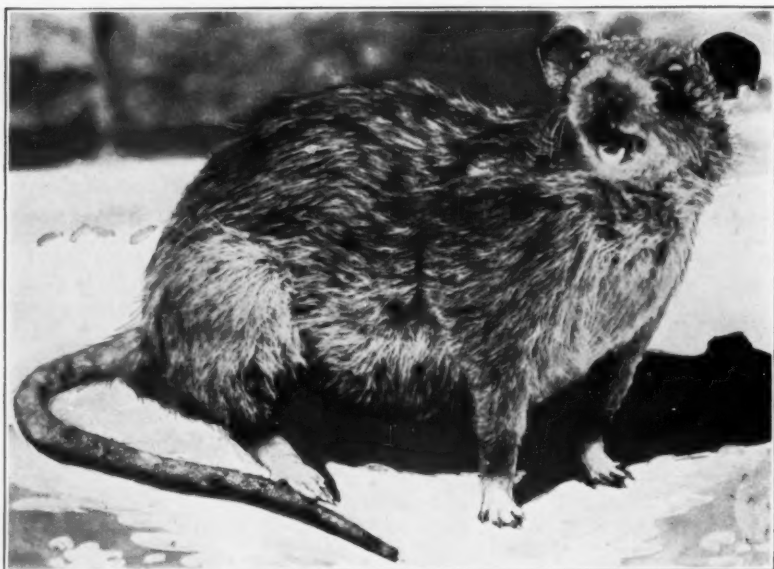
- (a) The several species of rats;
- (b) Their habits and customs, and
- (c) The places where they establish homes and shelter their young.

There are three varieties of rats (genus *Rattus*) in the United States, exclusive of mice (*I*), the larger species of which are frequently included in the term "rat."

The "brown rat", *Rattus norvegicus*, variously known as the Norway rat, barn rat, house rat, or sewer rat, is best known to the public and is the most common and widely distributed member of the rat family outside of seaports. Larger and more ferocious than other rats, it maintains an easy supremacy in its own sphere of activity which is at and below ground level.

The "black rat", *Rattus rattus rattus*, otherwise known as the English rat or ship rat, was introduced to Europe in the twelfth century and was transferred to America about 4 centuries later. This antedated the arrival of the brown rat by at least 200 years.

The "roof rat", *Rattus rattus alexandrinus*, or Alexandrian rat, held by many to be a race of the same species as the black rat, is considered to have originated in Egypt.



RATTUS NORVEGICUS (BROWN RAT).



RATTUS RATTUS RATTUS (BLACK RAT).



RATTUS ALEXANDRINUS (ROOF RAT).

The three species vary widely in appearance, and pure examples may be distinguished with ease. The brown rat is larger than other rats, is heavily built, blunt nosed, and has relatively small ears and a thick, rough tail usually not quite as long as the body. The black rat is about two thirds the size of the brown rat, has bluish-black fur, a smaller, more pointed head, large rounded ears, and a smaller tapering tail, which is longer than the body. The roof rat is between the brown rat and the black rat in size, and its fur is light gray on back and sides, with white belly. The tail is long and slender, similar to that of the black rat, and is used to maintain balance in climbing.

The brown rat is the most prolific of the three species, producing from three to five litters per annum, with from six to nine in each litter. Litters of more than 20 brown rats have been recorded. The average litter of the black rat is five.

The breeding of rats is apparently limited only by the food supply and opportunities for nesting and harboring. The perpetuation and increase of species, however, is not entirely due to fecundity. The animal in its fight for survival has developed remarkable resourcefulness and cunning in adapting itself to live with man and in evading its natural enemies.

#### HABITS

A knowledge of the rat's habits is essential to intelligent effort toward its destruction.

*Brown rat.*—The brown (Norway) rat keeps mainly to the lower floors and basements of buildings, as it lacks the ability to climb, which is so remarkably developed in the roof rat and black rat. The brown rat is essentially a burrowing animal and by preference lives and breeds in excavations. It will burrow into the ground to nest when it already has sufficient covert beneath floors to insure protection. The burrows regularly extend from one-half to 1 foot in depth, but rats have been observed to excavate beneath walls 2 or more feet deep. The brown rat burrows into the hardest soil, such as well-packed clay, with comparative ease.

This rat has a well-developed gnawing mechanism against which few materials are proof. It has been known to perforate walls constructed of sun-dried brick laid in sand and lime mortar, in one instance gnawing through the body of the brick (see pl. 30), but more frequently going through the wide interstices filled by the mortar. Instances have been noted in which a rat has been able to gnaw holes in slate, and lead pipes have often been pierced by its teeth. Solid wooden beams (see pl. 30), interrupting a favorite rat run, have been notched by the rat to a depth of 2 or 3 inches to permit a more comfortable passage.

In swampy regions the brown rat has adapted itself to semiaquatic habits and when put to the test has been known to swim one-half



mile in the open water of a bay, remaining in the water for an hour and a half and swimming against the wind in a choppy sea. The brown rat will eat anything without regard to the degree of freshness or decay.

*Roof rats and black rats.*—Unlike the brown rat, the black rat and roof rat are superior climbers and jumpers. The black rat ordinarily does not burrow but lives in hollow walls, garrets, or loose material such as empty boxes, barrels, or any rubbish, and within buildings it frequents the upper stories and roof, away from its enemy the brown rat. It climbs pipes, wires, and exposed uprights with the greatest facility. The black crescents made by these rats on exposed beams just beneath the roofs of buildings are striking evidence of their activity and extreme agility. These marks originate from grease and dirt on the rat's fur as he swings under the joists where they cross the beams.

These rats can run and play on an uninsulated telephone wire apparently as easily as a person walks across a level floor and with as perfect balance. An empty metal can 2 feet deep is not sufficient to retain the black rat.

Both black rats and roof rats are clean in their habits and prefer grain and clean, fresh food. The dietary preference of these rats therefore should be considered in the selection of bait when trapping is undertaken.

Rats are strictly nocturnal in their habits and can see best at night. When traveling in the daytime the rat seems uncertain of its movements, except when running along a wall, where its vibrissae, or whiskers, apparently are of service in guiding it.

The black rat is even more wary than the brown rat and is consequently more difficult to trap. It is rather exceptional to catch a black rat in a cage trap; snap traps and dead falls are more reliable for capturing this species.

Rats are travelers both by foot and by securing transportation. Extensive migrations of rats have frequently been noted, and a seasonal movement of rats from houses and barns to open fields in the spring in search of fresh, green food, is recognized as a periodic occurrence. The return migration occurs in the autumn.

From a number of trapped rats marked and released in a large city, one was recaptured 2 days later at a point 1 mile distant from the point of liberation and in the course of 2 weeks several were retaken, 2 and 3 miles from the point of release. Their travel had been through a thickly populated area of the city and across city streets, some of which were heavily traveled thoroughfares.

#### HOMES OR HARBORAGE

Successful propagation and perpetuation of a species is possible only when food and drink and, above all, shelter in the form of home or nest,

are available. Rats have survived for centuries and have successfully resisted all efforts to exterminate them because they have been provided with homes and suitable facilities for breeding and for protecting their young until maturity. Because little or no thought has been given to the matter, man has provided and continues to provide spaces especially adapted for rat homemaking, and in many instances he provided them also with an adequate food supply.

Nearly everybody is familiar with some of the rat homes more commonly seen beneath floors and behind walls or in similar locations, but the fact that *any* enclosed space to which rats may have access is a potential rat harborage and breeding place is not generally appreciated. So far as buildings and structures are concerned, rat harborage is divided into three general classes:

- (a) Structural.
- (b) Incidental.
- (c) Temporary.

Examples of each of these classes are as follows:

(a) *Structural*.—Double walls, space under floors, hollow-tile partitions, enclosed stairways, boxed-in waste and other pipes, hollow boxed molding, raised floors and gratings; (b) various types of furniture and fixtures; (c) trash of all kinds, old discarded furniture and equipment, boxes and similar material.

Plates 22, 23, 24 and 28 show typical examples of harborage of the structural type commonly found in many communities in buildings used for business purposes. They show the location and character of the home and the structural or other condition that made its use possible. These harborages are the logical result of the following conditions:

First, the employment of a design and type of construction which results in the formation of unnecessary enclosed spaces in the structure of the building. Second, the use of building *material* which is *not ratproof*, making it possible for the rat to gnaw holes in it and gain access to enclosed spaces. Third, the employment of faulty or careless methods of construction and installation. Failure to inspect and check finished work to detect defects and incomplete work as shown in plate 26, gave the rat "the key to the castle" and an open invitation to enter the enclosed space and make his home.

(b) *Incidental*.—Plates 24 and 25 present examples of incidental harborage. Such harborage is located in fixtures and furniture. Surveys have shown that approximately 30 percent of existing rat infestation is to be found in such equipment. The reason the rat selects it and its availability are the same as have been previously described.

(c) *Temporary*.—Plates 26 and 30 illustrate types of temporary harborage which may be found in the basements, cellars, and attics



of many structures. In some instances these piles of old material and rubbish have remained undisturbed for many months and sometimes for years.

#### THE PUBLIC

The second factor in rat control is the public, which is the victim of and the sufferer from the rat's depredations from both economic and health viewpoints. As long as the public remains passive and manifests no real interest in this matter, no real progress in rat control is possible. It is the public that provides the rat with all of the necessities of life, i. e., a secure home and food. Therefore no results of a permanent character can be obtained until the public not only becomes conscious of the presence of the rat but understands the conditions under which it best thrives and multiplies and the ways and means that are available and may be employed to correct such conditions.

This objective can best be attained through education, which should be practical and concrete and which should be brought to the very doorstep of the property owner or occupant of the building concerned. The various types of rat harborage must be demonstrated and the practical methods of eliminating or correcting them explained.

The conduct of such an educational campaign will require careful and painstaking work but it is well worth the effort, for it will lay a solid foundation of understanding of the various aspects of the problem, inspire public confidence, and result in a more wholehearted cooperation. Each owner or tenant should understand that in permanently controlling rat life on his premises, he is making his contribution to the general welfare. From the viewpoint of the promotion of public health in a community, it is of greater value to have one person voluntarily carry out approved measures of permanent rat control on his own premises and permanently to maintain ratproof conditions than to force a number to do so through legal procedure.

#### CONSTITUTED AUTHORITY

The third factor is constituted authority, and this is one of the most important factors. The success of the undertaking depends upon how well necessary educational, technical, legal, and administrative corrective measures are planned and carried out. For this reason all measures proposed for accomplishing rat control should be carefully studied in the light of the knowledge and experience which have been acquired, and recommendation for approval should be given only after most careful investigation has shown that they meet the essential and fundamental requirements.

Constituted authority in the form of State, municipal, or county governments can render most valuable aid in the campaign for permanent rat control by—

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(a) Enacting legislation which will empower the health department and other related agencies to deal fundamentally with the rat-control problem and to promulgate such rules and regulations as might be considered necessary to accomplish this purpose.

(b) Enacting legislation which will provide for the education of the public on the subject of permanent rat control through the medium of lectures and demonstrations—

1. In the public schools and higher institutions of learning and other places of assembly;
2. Through first-hand and personal contact of owners and occupants of buildings; and
3. Through talks to civic organizations, architects, builders, and mechanics engaged in the construction and repair of buildings.

(c) Enacting and enforcing legislation that will provide for the ratproof construction of all types and classes of buildings which may be deemed necessary to safeguard the public health. Authorize and provide for the inspection of such type of construction and for periodic inspections to insure upkeep of the ratproof status.

### TECHNICAL AIDS

The fourth factor is the technical vehicle, or standard guide, for use in accomplishing the task. No matter how well recognized the necessity for effecting rat control may be, or how desirous and willing the public may be to assist in executing such measures, their efforts will be more or less wasted unless a well-devised technical plan has been provided and followed.

### SUMMARY OF FACTORS IN RAT CONTROL

To summarize, there are four fundamental factors to be considered in rat control:

1. The rat, whose habits and mental attitude do not materially change, being a somewhat fixed quantity if he remains undisturbed. He does change his habitat or nesting place, however, as often as conditions make such change necessary. Basically, his nesting place is essentially the same, an enclosed and protected space if it can be found, whether it be a burrow beneath a walk or floor, between double walls, ceilings, or in the bases of fixtures or furniture. Since we cannot change either the habits or the psychology of the rat, the only factor over which man can exercise control is in connection with the place in which the rat establishes his home. Man can say and determine to a great extent, particularly regarding buildings and fixtures, whether or not a rat will be provided therein with a permanent home.

This is a matter over which man can exercise almost complete control and operate with some assurance of success.

2. The public, whose habits and mental attitude are also to some degree fixed; and while the design and type of buildings may be changed, enough of the traditional harborage features are too frequently retained, and the rat is furnished with a permanent place of abode. It is therefore desirable that the mental attitude of the public undergo a change, enabling much needed reforms to be effected.

3. Constituted authority is necessary. Legislation vital to the success of the undertaking of obtaining and maintaining permanent rat control can be more easily secured when the majority of people have been prepared by education and personal experience to recognize the necessity and wisdom of such action, and understand and appreciate the benefits which it will confer. The education of the public in the manner indicated will prepare the field for such legislative action, and, what is more important, for faithful compliance with the provisions of such laws and regulations.

4. Technical aids are also essential. The fundamental requirements for preventing rats from occupying enclosed spaces within our buildings and their equipment are as follows:

- (a) Employment of a design which eliminates unnecessary enclosed spaces or, if this is not possible,
- (b) The use of material that is impervious to rat gnawing, and
- (c) Its installation in a ratproof manner.

All ordinances, rules, regulations, and specifications should be drafted so as to provide for these fundamental requirements.

The thoroughness with which the detailed technical specifications are prepared and the care with which they are applied will determine the degree of success following the application of this technical factor in the campaign to build out the rat.

Once model, basic, enabling ordinances are passed, standard detail specifications, rules, and regulations can be promulgated, and they can be amended or changed from time to time to meet new conditions as they arise.

It will be seen that each of these factors mentioned plays a most important role, and for that reason must be seriously considered in its relation to the others as well as to the general problem. Advantage must be taken of the knowledge of those conditions which can be changed and which readily lend themselves to correction.

If, through education first and regulation afterward, the attention of the public can be focused on this problem; if the mental attitude of the public can be changed so as to demand buildings, equipment, and fixtures which are inherently free from spaces that provide rat homes and breeding places; and if the public can be induced to cultivate habits that will insure satisfactory maintenance and upkeep,

effective cooperation will be assured and the necessary legal and technical vehicles required for putting into effect the measures deemed necessary will be provided.

The elimination of rat harborage by ratproof construction does more than interfere with normal breeding; it reduces the flea index to the point where continued transmission of plague is not possible (8, 9). This probably operates in a similar favorable manner with reference to typhus fever, reducing the risk of transmission of this disease.

### Ratproofing of Buildings

#### ELIMINATING HARBORAGE

The ratproofing of buildings and of the equipment and fixtures installed therein is a dual problem involving not only the elimination and correction of rat harborage in existing buildings but the planning for basic ratproof construction of new ones. In order to do this successfully, the defective or unsatisfactory conditions which have resulted in the creation of rat harborage must be known and recorded, so that similar mistakes may be avoided when plans for the construction of new buildings are being considered and drafted.

The accompanying tabulation presents a list of the principal enclosed spaces in buildings and fixtures which serve as rat harborage. The several types are classified and a brief description is given of each. Suggestions are made for the elimination or correction of each harborage condition found in existing buildings and for the employment of a design, together with the class of material which is fundamentally ratproof, in the construction of new buildings.

*Tabulation showing various types of harborage and methods of elimination*

Examples of structural and incidental defects that are responsible for the usual rat harborage found in buildings	Methods suggested for correcting these defects	
	In new buildings	In existing buildings
1. STRUCTURAL		
a) Foundation and structural walls: Harborage may be available in the crevices and interstices if not properly pointed up or plastered, and below footings if foundation walls extend less than 3 feet below ground surface. (See pls. 22, 28, and 30.)	(a) Foundation walls should be built of approved ratproof material, plastered to a smooth surface and should extend at least 3 feet below ground surface. Structural walls should be solid without enclosed spaces. (See pls. 1 and A.) All openings through which feed lines and sewer pipes pass should be closed with ratproof material. (See pl. 28.)	(a) When the material of which foundation walls are constructed has become disintegrated, it should be repaired and plastered to a hard, smooth surface. All such walls should extend at least 3 feet below ground surface. All openings around feed lines passing through such walls should be tightly closed with metal collars or cement fill. (See pl. 28.)

## Tabulation showing various types of harborage and methods of elimination—Contd.

Examples of structural and incidental defects that are responsible for the usual rat harborage found in buildings	Methods suggested for correcting these defects	
	In new buildings	In existing buildings

1. STRUCTURAL—Continued		
<p>(b) Floors: Harborage exists in the space below the floor in cases where the floor is built so that it rests practically on the surface of the ground. If the cellar or basement ceiling is sheathed or lined, thus forming an enclosed space, rat harborage also is provided.</p>	<p>(b) Design a floor which is a solid mass with no intervening spaces. (See pl. 6.) Should there be a formal cellar space below the main floor, provide in the design for the elimination of the usual enclosed ceiling installed for fire protection or other purposes and the substitution therefor of the method of installing such material as shown in plate 16, which eliminates the enclosed space that furnishes rat harborage. Loading and other types of platforms should be designed and constructed as shown in plate 6. It is recommended that concrete be used in their construction and that the space below the platform be eliminated.</p>	<p>(b) If floor is so installed or constructed that it rests practically on the ground surface, it should be ratproofed by installing a concrete wall on all four sides, which extends 3 feet below ground surface (if one is not already in existence) to protect the floor from outside invasion. If there is such a wall it should be inspected to see that it is intact. If it is not, it should be repaired and made so. The surface of the floor and of the interior walls above it should be ratproofed as shown in plate 16. The exterior walls above ground surface should be made intact and ratproofed as indicated in plate 1.</p> <p>Floors of buildings which are built on pillars and elevated above ground surface should be protected from rat invasion by the installation of protective metal strips or other ratproof material as shown in plates 1, 5, and 16. Sheathing material installed on the under side of floor beams in cellars should be removed in every case where this is practicable. If sheathing is required for fire protection or other purposes, it should be installed flat against the sides of the beams and the under side of the floor boards as shown in plate 16. Ceilings already installed, and which it is not practicable to remove, should be repaired, then ratproofed by installing metal collars, metal flashing, etc., as shown in plate 16.</p>
<p>(c) Partition walls and upper floors: Harborage exists in the enclosed spaces formed by the double walls and lined ceilings. (See pls. 22 and 27.)</p>	<p>(c) Partition walls, wherever possible, should be constructed so as to be devoid of enclosed spaces. Where this is not possible, ratproof material should be used in their construction especially at the points indicated in plate 16. Where openings have been made in double walls for the passage of pipes and other feed lines, they should be closed and protected by the installation of approved metal collars, securely fastened to the adjoining structure. (See pls. 5 and 16.)</p>	<p>(c) All double wall partitions in existing buildings should be ratproofed and protected from rat gnawing and invasion at the points indicated in plate 16.</p>
<p>(d) Stairways sheathed on under side: Harborage is present in the enclosed spaces formed by the stairs and the lining or sheathing installed on the under side of stairs, also in the boxed-in lower step at the foot of the stairway. (See pls. 28 and 30.)</p>	<p>(d) Design and build stairways that are free from sheathing or boxed-in spaces beneath. Avoid construction of enclosed steps at floor level. (See pls. 15 and 31.)</p>	<p>(d) The sheathing installed on the under side of stairways should be removed wherever practicable so as completely to eliminate this type of enclosed harborage. (See pl. 15.) In exceptional cases where this cannot be done, the wooden sheathing should be ratproofed by the installation of protective metal flashing along all edges.</p>



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Tabulation showing various types of harborage and methods of elimination—Contd.

Examples of structural and incidental defects that are responsible for the usual rat harborage found in buildings	Methods suggested for correcting these defects	
	In new buildings	In existing buildings
1. STRUCTURAL—Continued		
(e) Raised flooring or platform units placed on top of original floor: Harborage exists in the enclosed spaces underneath such floors or units. (See pl. 23.)	(e) No platforms or raised floors having enclosed spaces below should be constructed. When it is necessary to have platforms several inches higher than the floor level they should be constructed of solid material, concrete or lumber, as shown in plate 15. Floors of offices installed in corners of warehouses should be installed in this manner.	(e) The use of raised platforms, the enclosed space of which provides excellent harborage, should be discontinued. If an elevated platform is necessary to provide dampproof storage of supplies, it should be converted into one of solid construction as shown in plate 15.
(f) Ventilating ducts and air conditioning trunk lines: Harborage is available on top of the ducts when they are installed in such manner as to be separated from the ceiling by only a few inches, and in the interior of the ducts when they are constructed of wood, and these as well as the outlet openings are not properly protected with ratproof material and screens.	(f) Ventilating ducts and air conditioning trunk lines should be constructed of approved ratproof material, preferably hard sheet metal, and they should be installed in a manner which will eliminate flat surfaces on top which can be utilized for rat harborage. Whenever possible use a cylindrical type of duct. (See pl. 21.)	(f) In existing ventilating or air conditioning lines, block out overhead spaces which serve as rat harborage by installing suitable metal flashing strips. Air outlets should be screened with an approved ratproof type of wire mesh or louvre.
(g) Window and other openings required for ventilation and other purposes: The type of design and manner of installation as well as the material used in the construction of these units are the main contributing factors which facilitate invasion of buildings by rats.	(g) Design screens for ventilating openings in cellars and elsewhere as well as louvres, as shown in pls. 4, 10, and 20. The frames of such openings should be constructed of metal or they should be metal sheathed. Close the openings between roof rafters as indicated in pl. 13. Cellar hatchways should be of concrete or brick plastered smooth, with steps of the open type, and doors and framework preferably of metal or of wood properly protected. (See pl. 2.)	(g) All ventilating openings installed in walls of cellars, basements, sidewalks, and elsewhere should be ratproofed by the use of approved type of screens preferably of perforated metal sheets, the openings of which should not be greater than $\frac{1}{2}$ inch. If wire screens are used they should be installed as indicated in pls. 3 and 4. Openings around roof rafters at wall plate should be closed with metal. (See pls. 13 and 19.) Cellar hatchways to be ratproofed as in pl. 2.
(h) Skylights: The factors mentioned in (g) are also responsible for invasion by rats through skylights.	(h) Design skylights so they fit snugly into a rabbetted frame, which should be constructed of metal or be metal covered. If the skylights are to be of an adjustable type which can be opened for ventilation, the under side of the opening should be screened as shown in pl. 14.	(h) Existing skylights should be reconditioned and made ratproof in conformity with the requirement set forth in sec. (h) of column 2.
(i) Elevator shafts and pits: Harborage is found in the interstices of the walls of the pit, in burrows which have been made in the soil at the bottom of the pit, and in the accumulation of trash. It is also found in the enclosed spaces between floors and ceilings when the shaft openings have not been properly closed with ratproof material. (See pl. 27.)	(i) Design and construct floors and side walls of pits of elevators so they will be devoid of harborage. Bottoms of pits should be covered with unbroken cement floors which should be tied into the 4 walls which form the pit boundaries. These walls should be constructed of cement or, if built of brick, should be plastered with a rich cement mixture. All openings in and around the shaft should be closed with approved ratproof material. (See pl. A.)	(i) Repair the side walls, replacing any missing bricks, stone, etc., and fill in all holes, seams, etc., with a rich cement plaster. Install a concrete floor in the bottom of the pit. Keep floor free of trash by frequent, periodic cleaning (weekly). Metal flash or otherwise effectively close all openings into double walls at floor levels through which elevator shaft passes. (See pl. B.)

Tabulation showing various types of harborage and methods of elimination—Contd.

Examples of structural and incidental defects that are responsible for the usual rat harborages found in buildings	Methods suggested for correcting these defects	
	In new buildings	In existing buildings
1. STRUCTURAL—Continued		
(j) Sliding and folding doors: Harborage is usually to be found in the recesses which house the sliding or hoisting doors. Note: For conventional type of wooden door subject to gnawing at bottom edges see pl. 29.	(j) Recesses which house such doors should be lined with metal and otherwise made ratproof as shown in pl. 8. The conventional type of door should be made of metal or material impervious to gnawing and fitted into a rabbetted sill. (See pls. 7 and 9.)	(j) Effectively close with sheet metal all openings in and around the recesses which house these types of doors by installing this material in such a manner that the space around sides of the sliding door will not be greater than $\frac{3}{8}$ inch. Metal sheath the lower frame of the door. (See pls. 7, 8, and 9.)
(k) Structural pillars, beams, girders, pipe lines, etc.: Harborage exists within the enclosure formed by boxed-in casings and sheathing. (See pl. 28.)	(k) Design and construct so that these members will be free of enclosed dead air spaces. If for reasons of appearance it is necessary to sheath them, use sheet metal that is ratproof and install it in a ratproof manner. (See pls. 12 and A.)	(k) Remove sheathing or casing wherever possible. When this cannot be done, protect all gnawing edges of the boxed-in casing or sheathing by installing approved sheet metal strips. (See pl. B.)
2. INCIDENTAL		
(l) Refrigerators: Harborage is in the enclosed spaces between the interior and exterior shells or walls, also in spaces beneath and behind the unit. If refrigerator tops are out of normal line of vision they may be used as harborage.	(l) Design refrigerators and Frigidaire units so they will be free from enclosed spaces which are accessible to rats. Use ratproof metal sheets in their construction. Install them in such a manner that there will be no partially enclosed spaces beneath, behind, or on the sides, which might serve as rat harborage. This can be accomplished by placing units flush against the walls, installing them in a solid cement base, or by completely encasing with metal flashing strips. In Frigidaire units where circulation of air is required, perforated metal could be advantageously used. Large commercial refrigerators, in addition to the above requirements, should be installed in such manner as to eliminate the overhead space which usually becomes a receptacle for all types of rubbish. (See pl. 15.)	(l) Protect the bottoms, tops, and other gnawing edges of wooden refrigerators by installing metal flashing strips. Spaces behind and on the sides of these units should be blocked off by the installation of metal angle strips. The bases of Frigidaire units should be made proof against rat invasion by closing all openings with perforated metal or approved wire screens. (See pls. 15 and B.)
(m) Store shelving and fixtures: Enclosed spaces formed by boxing in the lower shelf furnish available harborage. (See pls. 24 and 25.)	(m) Design shelves and fixtures so they will be devoid of boxed-in spaces at bases, or construct them of material which is impervious to gnawing. Such fixtures, if of metal and of the enclosed type, should be fitted snugly to the adjoining walls and floors, with no intervening spaces between. The open type of shelving is fundamentally ratproof since it eliminates the enclosed spaces which form harborage. The solidly filled-in base also eliminates harborage and is an approved type. (See pls. 7, 18, and A.)	(m) Eliminate rat harborage in existing fixtures by opening the boxed-in enclosures at base of shelving, then treat fixture as suggested in section (m), column 2. (See pls. 7 and B.)

# 16 THE RAT AND RATPROOF CONSTRUCTION OF BUILDINGS

Tabulation showing various types of harborage and methods of elimination—Contd.

Examples of structural and incidental defects that are responsible for the usual rat harborages found in buildings	Methods suggested for correcting these defects	
	In new buildings	In existing buildings

2. INCIDENTAL—Continued		
(n) Bins installed in grocery and other stores: The spaces between the store floor and the raised bottom of the bin, also between the back of bins and the wall, furnish harborage.	(n) Bins should be designed so there will be no enclosed space at the bottom, and installed either in the open or snugly against the wall and floor. Use metal in their construction or at least completely line the interiors with sheet metal. A type of metal, portable bin which is both ratproof and sanitary is embodied in the commercial or household ash can when it is equipped with a well-fitted lid. (See pl. A.)	(n) Wooden bins of the old type already in service should be repaired, then ratproofed by metal lining the interiors and installing metal flashing around the outside, bottom edges. Block out any existing space between the back of the bin and the adjoining wall, by installing metal strips on the tops and sides of the bins. (See pl. B.)
(o) Counters and display fixtures: The enclosed space formed by boxing-in the lower section of fixtures furnishes the harborage.	(o) Design counters and display units so they will be free from enclosed spaces at the floor level, either by elevating them 10 or 12 inches or by installing them in ratproof, sanitary bases. (See pl. A.)	(o) Eliminate enclosed spaces in existing old style counters and display fixtures as far as practicable. Install metal flashing along the gnawing edges and possible points of invasion of the boxed-in bases or foundations, and the spaces back of drawers, etc. (See pl. B.)
(p) Desks: In desks of the old types, harborage is to be found in the boxed-in lower section which rests on the floor. Spaces in backs of roller top desks are also available for harborage.	(p) Desks should be of the flat top, sanitary base type, installed on legs which give an elevation of 10 to 12 inches above the floor. (See pl. A.)	(p) Old types of wooden desks which rest flat on the floor should be ratproofed as indicated above for display units, show cases, etc. (See pl. B.)
(q) File cases: In file cases constructed of wood, harborage is located in the boxed-in lower section and the space at the back of each drawer. When a number of file cases are installed in a row and are not fitted flush against the wall, the space behind such units provides harborage.	(q) Use all-metal file cases and install them in such manner that there will be no intervening spaces between the backs of the cases and the adjoining walls. The cases should rest flat on the floor or be elevated as indicated in section (p), column 2. (See pl. A.)	(q) The bases of old style wooden file cases should be flashed with metal strips. All types of file cases which rest flat on the floor should be installed close against the wall, thus eliminating intervening spaces between back of cases and wall. If this is not possible, such spaces should be blocked off by the installation of metal angles or strips across the top and at the side of the cases, or by fitting a solid, continuous wooden pad between wall and file cases. (See pls. 7 and B.)
(r) Lockers, book cases, etc.: Harborage exists in the enclosed base, the space behind, and the flat surface on top of such fixtures or equipment.	(r) Design and install lockers, book cases, etc., so they will be free from enclosed, boxed spaces at the base. (See pl. A.)	(r) Eliminate the enclosed hollow space in the bottom of such units, or protect it as indicated in section (q). (See pl. B.)
(s) Boxed-in seats or settees: Spaces formed in back and beneath seat furnish harborage.	(s) Boxed-in settees or enclosed spaces should be eliminated in the design and construction of settees or window seats. They should be of an open type so far as the space beneath is concerned. (See pl. A.)	(s) Install metal flashing around the edges of boxed-in settees, or line the interiors with metal. Install metal collars around all pipe lines passing through the sides of settees. Where possible, eliminate enclosed space. (See pl. B.)

3. TEMPORARY		
(t) Trash and litter of all kinds, boxes, barrels, etc. (See pl. 26.)	(t) Arrange for the prompt disposal of trash, boxes, etc., to prevent accumulation thereof.	(t) Existing heaps of rubbish, boxes, and litter should be immediately removed and disposed of. The compartment or ground space should then be cleaned and kept in that condition.



Tabulation showing various types of harborage and methods of elimination—Contd.

Examples of structural and incidental defects that are responsible for the usual rat harborages found in buildings	Methods suggested for correcting these defects	
	In new buildings	In existing buildings
3. TEMPORARY—Continued		
(u) Discarded fixtures, equipment, etc. (See pls. 26 and 30.)	(u) The same treatment as indicated above in item (f).	(u) Dispose of discarded fixtures, equipment, etc., or store them in a ratproof compartment.
(r) Old records, books, etc.	(r) Construct a ratproof compartment for the storage of such articles. The compartment should be kept closed at all times except when materials are being placed therein or removed therefrom. (See pl. A.)	(r) Remove articles, clean out trash, then provide a ratproof compartment or ratproof containers for storage of such articles. (See pl. B.)
(w) Mass storage of supplies for long periods: Harborage is available in the supplies or stores.	(w) Stores of this character should be kept in a ratproof compartment as suggested in item (r).	(w) The transfer of supplies of this character from one location to another each week will minimize the opportunity for rats successfully to utilize this material for harborage, as they will be detected. This treatment is recommended only as a temporary expedient pending construction of a ratproof compartment.

## MARKETS, INCLUDING CURB MARKETS AND FARMER'S MARKETS

Buildings which are being used or are intended to be used as public markets should be ratproofed as indicated in the preceding tabulation. The walls and floors should be constructed of concrete and should be devoid of hollow spaces. The concrete floor should be tied into the structural walls as shown in plates A and 6.

The fixtures and display counters with which the stalls are equipped should be of an approved ratproof design, devoid of enclosed spaces. These fixtures should be installed in the open as far as practicable. If placed against the wall, they should be installed as indicated in plates 7 and 18.

Curb markets which are housed under sheds should be made ratproof by installing an approved type of ratproof concrete floor which should be protected by marginal walls extending 3 feet below the surface as shown in plate 17. Should any curtain walls be installed around stalls, they should be of a single wall type and elevated about 10 inches from the concrete floor in a manner similar to that shown in plate 11. If pipes are employed for framework, all open ends of pipe should be capped.

Shed-type roofs should be flashed as indicated in plate 12.

Only approved types of ratproof fixtures should be permitted in the stalls of either type of market. Refrigerators should be of a design that is ratproof and should be installed in a ratproof manner as indicated in subitem (l) of the tabulation preceding this.

## 18 THE RAT AND RATPROOF CONSTRUCTION OF BUILDINGS

The use of wooden floors, elevated platforms, or floor gratings should not be permitted. The use of wooden lockers, boxes, packing cases, etc., for storage of supplies should be prohibited.

### SIDEWALKS

The construction of plank sidewalks should be avoided. Concrete walks with marginal protection to prevent rats from burrowing beneath should be constructed instead.

### STABLES

[Reference 3]

The sustaining walls of stables should be constructed of concrete or of brick and stone laid in cement mortar. If built of this material the walls should be not less than 6 inches thick and should extend 3 feet below the ground surface, as indicated in plate 6.

The floors of stables should be of heavy concrete not less than 4 inches thick, which should be dressed to a smooth surface with cement and sloped to provide proper drainage.

Double floors, double walls, double ceilings, or other enclosed spaces should not be permitted in buildings used as stables.

All feed bins should be of an approved ratproof design, constructed of cement or metal, and equipped with close fitting doors. If constructed of wood, the bin should be lined or covered with sheet metal, galvanized iron, or other non-corrosive material and so protected as to prevent rats from gnawing. These bins should be free from any enclosed spaces at their bases and should be installed in a manner which will eliminate the possibility of the creation of harborage.

The use of galvanized iron garbage cans equipped with tight-fitting covers is suggested for the storage of feed.

### POULTRY HOUSES

In the construction of poultry houses, the elimination of double walls, of spaces beneath floors, and of enclosed spaces in and around nest boxes and feed bins is the prime objective. The floors and foundation should be of concrete, and the type of construction should follow the fundamental methods suggested in the preceding general tabulation.

The smaller wooden type of poultry house (14) which is built on pillars should be elevated at least 2 feet from the ground surface and constructed as indicated in the tabulation, care being taken to eliminate double walls and other enclosed spaces and to protect the usual points of rat ingress by installing the protective ratproof material indicated in the tabulation.

## WHARVES

The ratproofing of existing wharves can best be accomplished by the elimination of the enclosed spaces in the wharf structure in the manner indicated in the several subitems of the preceding tabulation. Double-walled partitions for office spaces, boxed-in casings, and bases around structural pillars, pipe lines, etc., double floors or deck planking, raised platforms, poorly constructed and nonratproof partitions of enclosures used to store ropes and gear required for use on the wharf, are some of the conditions which offer harborage for rats.

In planning the construction of new wharves of a ratproof type, every effort should be made to eliminate harborage by designing a wharf structure that is free from such enclosed spaces, and after it is constructed to see that none are built in or installed.

Such design and planning should include the elimination of ledges on stringers, frames, or decking which are not washed by tidal water each day. The adjacent shore line should be protected by the construction of approved ratproof type of concrete bulkhead, which should be "tied" into the concrete decking of the wharf and the bulkheads or walls of the adjoining shore line. Shore slopes which are normally above the water line should be "built out" (15) by installing concrete walls or ratproof bulkheads around all four sides, the outer bulkhead being located at a point where its base is touched by tidal water at all times, and the entire space within the enclosure being filled in and sealed with the concrete decking or flooring of the wharf. It would appear feasible also to excavate the earth or other material which forms the sloping shore line to a depth slightly below mean low water. It would then be necessary only to build a ratproof concrete bulkhead at the shore line as previously indicated.

Doors and other openings installed in wharf structures should be of the type shown in the subitem of the tabulation. The correction of those that are defective should be made in accordance with the suggestions made therein.

## SANITARY PRIVIES

Plate 17 illustrates the ratproofing of the space beneath the concrete floor of sanitary privies, thus preventing rats from burrowing around the edges of the floor and nesting beneath the slab, thereby breaking the seal and permitting flies and mosquitoes, as well as rats, to enter through such holes and gain access to the excreta.

## MATERIALS OF CONSTRUCTION

Concrete for use in ratproof construction should be of a good rich mixture, composed of clean, sharp sand, and stone or gravel aggregate.

Bricks should be of a hard surface free from defects.

Metal for use in flashing gnawing edges or other protective purpose should be galvanized iron sheets or the equivalent of an approved width, and of no. 18 U. S. gage.

The use of wire mesh or expanded metal should be discouraged, particularly in locations where it is likely to be damaged or broken. Sheet metal with perforations not exceeding one-half inch will give more efficient results and will remain longer intact. In the case of rectangular, horizontal, or vertical openings, such as in louvres or between sliding doors and building walls, the maximum width of opening should not exceed three-eighths inch, to prevent rat ingress.

When screens are used they should be well anchored in substantial metal frames which are firmly secured to the surrounding structure. When screens are installed in wooden frames or molding, the metal should extend to the outer edge of the frame. (See pl. 20.)

The suggestions given in the various sections of the preceding tabulation and the general specifications which accompany plates A and B, showing design and corrective ratproofing work, are in accord with the fundamental requirements embodied in the draft of the model ratproofing ordinance which is presented in the appendix.

#### RATPROOFING ORDINANCE

The ordinance shown in the Appendix fundamentally provides for the following:

- a. Makes it unlawful to construct buildings that are not ratproof.
- b. Confers jurisdiction and empowers the health officer to draft, promulgate, and enforce rules, regulations, etc., deemed necessary to accomplish the purpose of the ordinance.
- c. Fundamental ratproof design and the use of approved ratproof material and employment of standard ratproof methods of construction and installation.
- d. The submission of plans for the construction of proposed buildings to the health officer for examination and approval.
- e. Authority to make inspections during construction and thereafter at regular intervals to insure satisfactory upkeep of ratproofing work.

#### SURVEYS AND RECORDS

Information obtained as a result of surveys and inspections should be recorded on standard forms. While condensed, it should be complete and cover all the points which have to be given consideration.

The two drafts of blank forms (one covering inspection of buildings and the other fixtures and furniture) shown in the appendix are suggested for use. Survey findings and inspection reports can be recorded on such forms with a minimum amount of writing by the sanitary officer or inspector making the inspection, and their use would insure

uniformity of inspection procedures and minimize the possibility of overlooking some important detail or condition.

It is desirable that the letter which contains suggestions for the correction of harborage conditions found, and which will be addressed to the owner or tenant of the building, should be standardized. It should give a brief description of the unsatisfactory rat harborage conditions and contain a definite recommendation for their correction, indicating the sections of the tabulation or specification which apply.

The following outline of a letter is suggested:

SIR: The inspection and survey of the premises or building located at ----- Street, -----, on -----, 193--, to ascertain its status as to rat harborage and rat infestation, revealed the fact that there exists the following unsatisfactory conditions which should be corrected at the earliest possible date:

1. *Cellar.*—Rat harborage found to exist in sheathing installed on underside of floor beams, under raised wooden floor of store room enclosure, and in the pile of old material and rubbish in the rear of the cellar.

Suggestions for correction of these conditions may be found in the tabulation, "The Ratproofing of Buildings" (copy enclosed), under the following headings:

Sheathing under floor:

Section 1, subitem (b).

Rubbish, old material, etc.:

Section 1, subitem (l).

2. *Fixtures and equipment.*—Rat harborage was also found to exist in the boxed-in lower shelves of the store fixtures and in the bases of the wooden bins.

Suggestions for correction are indicated in—

Section 2, subitem (m) for shelving, and

Section 2, subitem (n) for bins.

(Name) -----

(Title) -----

If suggestions and recommendations listed in the chart have been incorporated in the specification for ratproofing promulgated by a State, city, or county official, the section or paragraph of such specification should be referred to and quoted.

#### TRAINING OF PERSONNEL

Sanitary officers, sanitary inspectors, and other personnel of the health department engaged in rat-control work should be given instruction on such subjects as the general history of rat life, the several species and their habits, types of harborages used for nesting, and home building. They should be thoroughly trained in the standard methods of conducting surveys of buildings and their equipment, planning for the installation of ratproofing work both in existing and new buildings, and supervising and inspecting such work to the end that it will be properly installed and maintained. They should be familiar with and know how to use the auxiliary and supplementary



measures commonly employed to destroy rats as indicated later; for trapping, poisoning, and other supplementary measures can be more effectively employed when harborage has been eliminated or corrected in buildings and equipment, as the establishment of permanent rat homes and successful propagation becomes more difficult.

#### Supplementary Rat Suppressive Measures <sup>1</sup>

Rats can be destroyed by trapping, fumigating, and poison baits, and by natural enemies, such as certain breeds of dogs and cats, ferrets, weasels, minks, foxes, mongooses, and certain birds of prey.

#### TRAPPING

If undertaken on a community-wide scale by careful, industrious trappers, trapping is one of the most efficient communal means of combating the rat. The snap or dead-fall trap is the instrument of choice. To succeed the trapper must be fully conversant with the rat's habits of feeding, running, and nesting, and the constant exercise of alertness and ingenuity in baiting and placing traps is demanded, for the rat is one of the most resourceful and wary of all semidomesticated animals.

Large cage traps, 20 inches in length, are more effective than smaller ones; but they have a limited field of usefulness. Great care is required to disguise the trap, and it is most useful in warehouses and other large structures used for storage purposes. Rats are not likely to enter cage traps in any buildings where there is much moving to and fro and shifting of merchandise.

The selection of bait to use in either snap or cage trap is not of so great importance as other considerations, as the rat is concerned with quantity and availability rather than with the quality of food. The most important consideration is to see that the only food easily available is that displayed as bait in the trap. It is hopeless to attempt trapping when the rat can get all the food he requires without risking his life to get it.

#### FUMIGATING

The use of gaseous fumigants, particularly those containing hydrocyanic acid gas, is attended with a high degree of success where a relatively large rat population lives in a circumscribed environment, as on shipboard or in a warehouse or grain elevator. Cyanide fumigation should be undertaken only by governmental agencies or licensed commercial firms, because of the great hazard to human life incident to the use of this lethal gas.

<sup>1</sup> See reference 1.

## POISONING

The destruction of rats with poisoned foods has always had public favor, and extensive poisoning operations have been undertaken by communities from time to time. The efficacy of this method is debatable, however, as it is practically impossible to tell whether rats are killed or merely migrate to a location where adequate amounts of food may be safely secured. It is certain, however, that when extensive poisoning is done, a disproportionately small number of dead rats are recovered, and when poisoned areas are energetically trapped after a short interval, satisfactory kills are made.

As is the case in connection with trapping operations, all foodstuffs must be carefully protected from rats except the poisoned bait. It should be remembered that human life and domestic animals are endangered by the average rat poison. Phosphorus is not only deadly to all animal life but, if used carelessly, may result in fires.

Contrary to common belief, rats dying from the effects of phosphorus die inside double walls or other inaccessible places, and subsequently the odor of decomposition makes most householders conclude that live rats are preferable to the foul odor emanating from dead ones.

The rat poisons commonly in use are mixtures containing phosphorus, arsenic, barium carbonate, strychnine, or plaster of paris.

*Phosphorus*.—Yellow phosphorus, from 3 to 5 percent, when mixed with glucose, is attractive to rats. Slices of stale bread are saturated with this mixture slightly thinned with tepid water, and then cut into small cubes for distribution. Rubber gloves should be worn when preparing these baits.

*Arsenic*.—Powdered white arsenic (arsenious acid), 15 percent, may be substituted for phosphorus in the preceding formula, or incorporated in a dough made by mixing corn meal with white of egg.

*Strychnine*.—Strychnine is not recommended for general use. It is an effective rat poison, however, and the following formula is suggested by Rosenau: Strychnine, 1 ounce; cyanide of potassium, 2 ounces; eggs, 1 dozen; honey, 1 pint; wheat or barley, 30 pounds. Stir eggs well, then mix in honey and again stir. Add dry powdered strychnine and cyanide and stir until well mixed. Put wheat or other grain in large box or can, pour in mixture of poison, and stir until thoroughly distributed over grain. Stir several times during 24 hours, then spread out and dry.

*Barium carbonate*.—Barium carbonate is recommended in many quarters as the cheapest and most effective rat poison. Human beings, domestic animals, and livestock are also susceptible to its effects, and so it must be used with caution. A dough consisting of

one part barium carbonate in four parts of corn meal or flour moistened with water may be made into small cakes or spread on slices of bread, meat, or vegetables.

*Plaster of paris.*—In the proportion of one part to two parts of flour, plaster of paris is a nonpoisonous preparation which, if eaten by rats, will kill them through the formation of enteroliths (hardened bits of plaster of paris forming in the intestines).

*Rat viruses.*—Rat viruses are not recommended on account of cost, uncertain action, instability, and the possible creation of an immunity to their effect.

The formulas of rat poisons which have been used with a considerable degree of success in antiplague campaigns conducted in Guayaquil and other places in Ecuador are described in Reprint No. 1409 from the Public Health Reports for September 12, 1930, and in an article entitled Choice of Rat Poison in Antiplague Work, published in the Public Health Reports for May 1, 1936 (10). These poisons were put up in packets containing the following ingredients:

(1) Coarsely ground corn meal, 35 percent; cheapest grade of wheat flour, 35 percent; grated cheese, ground dried fish, dried blood, finely ground dried beef or pork, or finely ground peanuts, 15 percent; and commercial arsenic, 15 percent. These ingredients were mixed in a large trough until uniformly distributed and were then put in small torpedo-shaped paper packets, each of which contained one teaspoonful of the poison mixture.

(2) Meat of fresh fish of a cheap variety, without bones, 85 percent; commercial arsenic, 15 percent. The meat of the fish is passed through a meat grinder and finely ground, the arsenic is mixed with this, and the whole mass is kneaded (rubber gloves being worn) until the mixture is complete and the arsenic thoroughly distributed. If the fish is not too oily, the poison product will be a thick paste, which may be spread on bread, pieces of paper, or shavings and then placed in or near rat holes and runs.

Other poison packets in use in Guayaquil, were composed of the following ingredients:

- (1) Flour and barium carbonate, 40 percent.
- (2) Corn meal and arsenic, 18 percent.
- (3) Flour and arsenic, 18 percent; and corn meal and arsenic, 18 percent.
- (4) Corn meal and barium carbonate, 35 percent.
- (5) Corn meal and dried powdered cheese, and corn meal and dried powdered codfish, both with barium carbonate, 35 percent.
- (6) and (7) Corn meal, dried powdered codfish, and arsenic, 18 percent; and corn meal, dried powdered cheese, and arsenic, 18 percent.

An editorial note at the end of article, Choice of Rat Poison in Antiplague Work (10), contained the following statement:



"The exclusive use of poison for the destruction of rats in the control of plague is a more or less temporary expedient unless continually repeated; as an urban antiplague measure, it presents a method of control which is quickly applicable and which should be used pending the realization of ratproofing and other antiplague measures of more permanent value. It is expedient to utilize repeated poisoning in impoverished communities where the more costly and permanent antiplague measures cannot be employed for economic reasons, and also in combating rural plague in sparsely settled regions or in maintaining rodent-free rural zones circumscribing and localizing a focus of plague infestation."

This view coincides with the observation of J. C. P. Grey, who, commenting in the *Malayan Medical Journal* for June 1936 (vol. 2, no. 2, pp. 115 and 116) on the Control of Plague in Java, stated: "The views of an outside observer on the important special measures of plague control which have been adopted in thickly populated Java are particularly valuable. Measures which have been tried and failed are isolation, fumigation, rat poisoning, and prophylactic vaccine. Stress is now laid on the improvement of the houses of the people who live in the country districts with a view to breaking down the close association between man and rat."

"The Javan house is built of bamboo posts, has thatch (attap) roofs, and is double walled. Improvement of such a house consists in replacing the bamboo (including the bamboo beds) with timber and the roof with tiles and closing the double space between the walls. When this is done the rats leave the houses 'for more congenial breeding places.' Unfortunately the process of improvement of the dwelling house is costly and the people are poor. Government loans are needed and are given to the householder. It is the owner who dismantles his own house and reconstructs it 'with the help and advice of the officers.' The reconstructed houses are inspected, passed, and again reinspected at intervals 'to ensure that they are properly maintained.' The success of these measures is evident. Plague started in East Java, spread to Mid Java, and is now in West Java. Reconstruction of houses naturally followed the same course. It can be shown that East Java is now practically free from plague. Plague is disappearing from Central Java, and the same thing is happening in those parts of Western Java where the kampongs have been reconstructed. With the reconstruction, the houses become brighter and cleaner; the populace likewise seems to reflect in their lives this brightening up of their homes."

#### STARVING

Rats require large and constant amounts of food, as well as quiet, well-protected places for hiding and breeding purposes. Interfere with these requirements and the rat's existence becomes a perilous

one. There is no more important suppressive measure than that of separating the rat from its customary food supply. This method of attack should be prosecuted in most scrupulous detail in homes, places of business, and wherever foodstuffs are handled, stored, or sold. Bulk foods in the home should be kept in ratproof containers and every occupied premise should be equipped with a ratproof garbage can, in which all remnants of food are placed. Garbage dumps should be eliminated from every community.

#### ANNOYING

Rats require safe covert when carrying on their ordinary affairs, and the elimination of rat hiding places makes life more difficult and exposes the animals to man's attack as well as to the attacks of their natural enemies. The usual clean-up campaign will not eliminate rats, as it does not strike at the source of the trouble; but it does good in that innumerable temporary rat shelters are removed. The brown rat wants a solid roof over his head and will burrow beneath floors and concrete paving with exposed edges. The roof and black rats look for double walls and dusty attics and are not concerned with the state of the backyard, be it clean or dirty.

The presence of certain animals has a rat-suppressive effect; but these may not be counted on to eliminate rats from a premise. In the first place, the animal in question is usually too well fed to hunt the rat aggressively; and, in the second place, the rat can and does frequent places which his natural enemy can not reach. Rats are naturally more at ease, however, where there are no dogs and cats, and the presence of these animals supplements other more specific eradicated measures.

#### Resolutions of International Conference

In the proceedings (5) of the Second Conférence Internationale et Congrès Colonial du Rat et de la Peste, which was held in Paris, in October 1931, numerous references were made, in the reports submitted, to the necessity for the ratproofing of buildings, wharves, and ships. Three major resolutions were adopted by this Congress. One had special reference to the ratproofing of ships and wharves; another to the incorporation of ratproofing requirements in the plans for the construction of buildings; and the third recommended the teaching of ratproofing in the public and professional schools. A free translation of each of these resolutions is given below.

*Resolution adopted on the proposal of Dr. Bohec, chief medical officer of the S. S. Ile de France.*—The last three hygienic congresses in France adopted a resolution that a study be made by a public authority on the methodical, absolute destruction of rodents.

At the Second International Conference and the Colonial Congress on Rats and Plague there was in turn proposed an official international regulation on ratproofing of ships and docks which was to be carried out by the health services.

This Congress therefore adopts a resolution in favor of ratproofing ships, primarily compulsory and officially controlled.

*Resolution adopted on the proposal of Mr. L. Plessy, Director of Veterinary Services and Delegate from the Department of Seine and Marne.*—That the various municipalities be invited to include in their sanitary regulations the requirement that the current principles of ratproofing be incorporated in the plans for the construction of buildings before permission is given for such construction.

*Resolution adopted on the proposal of Mr. Robert Regnier, Director of the N. W. Station of Animal Husbandry and of the Museum at Rouen, Delegate of the Institute of Agricultural Research.*—\* \* \* Third. That the attention of Governments be drawn to the necessity of teaching, in the professional schools, measures of protection (ratproofing) and in the public schools the importance of deratization as a safeguard of public health. These conferences should sponsor the establishment of an annual Rat Week, according to the example of other countries.

#### **Ratproofing Design for New Buildings**

(Identifying numbers refer to numbers shown in circles on pl. A)

1. *Footings and foundation walls.*—Walls should be of solid construction, continuous, and devoid of openings, and should extend a minimum of 3 feet below surface of ground.
2. *Cellar or basement flooring.*—Should be mortised into foundation wall, be continuous over whole ground surface, and be of sufficient thickness to insure permanency.
3. *Cellar steps.*—Should be of an open ratproof type.
4. *Elevator shaft.*—Should have a concrete floor similar to one described for cellar. Walls of pit should be of concrete or brick plastered smooth.
5. *Raised wooden floors or floor gratings* are eliminated.
6. *Closets and enclosures which form harborages* are eliminated.
7. *Cellar openings.*—Ratproof types.
8. *Double walls above cellars.*—Design and construction methods which prevent invasion from cellar into double-wall spaces.
9. *Sheathing under floor beams.*—Design which dispenses with the use of under beam linings or sheathings.
10. *Design which eliminates enclosed spaces and is also fire retarding.*
11. *Fire retarding material* (composition or metal sheets) installed on underside of floor beams, which installation has been made ratproof.
12. *Structural walls above foundation.*—Ratproof material should be used, and approved methods of construction should be employed in walls and foundations. Wherever possible, eliminate double-wall construction. Keep bricks well pointed up if double walls are employed. All material used should be of a ratproof character.
13. *Doors, windows, and other openings.*—The design and material used, as well as the methods employed in construction and installation, should be ratproof.

14. *Main floor.*—Should be constructed of concrete or of approved composition material and should extend to and be mortised into the structural walls on all sides.

15. *Floor construction of wood or other nonratproof material* should extend to ratproof baseboard, but the protective ratproof material must extend to the side walls and be fitted thereto. Approved ratproof collars should cover all openings around pipe lines passing through floors or ceilings.

16. *Baseboards or mop boards.*—Should be of material impervious to rat gnawing, i. e., cement, metal, marble, or approved composition.

17. *Structural pillars.*—Should be of solid construction in all cases where possible. Metal sleeves, casings of approved ratproof material, i. e., metal or composition impervious to rat gnawing, also may be employed.

18. *Partition walls.*—Should be of single-wall construction where possible.

19. *Insulated boxed and structural beams.*—Sheathing material should be of an approved ratproof character, installed in a continuous and unbroken manner. Openings around the plates at junction of beam and pillars should be effectively closed.

20. *Trap door to attic.*—Should be well fitted into a rabbeted frame. The door itself should be constructed of metal or other fire and ratproof material, and it should be hinged.

21. *Space over wall plate between roof rafters (under eaves).*—Should be filled in with snugly fitted ratproof material either perforated sheet metal or heavy wire screening.

22. *Attic flooring.*—If floor is desired, it should be of a permanent character and protected at all gnawing edges with sheet metal.

23. *Skylights.*—Should have a substantial metal frame and screen which is hinged to frame. Openings in screen should not exceed one-half inch in diameter or width, and in parallel sided louver openings should not exceed three-eighths inch width.

24. *Outlets for electric- and telephone-service lines.*—Openings made in wall permitting passage of outlet fixtures should be sealed with cement or other ratproof material.

25. *Roofs.*—Material used and the manner of installation should be such as to provide no enclosed spaces which can be used for harborage.

#### EQUIPMENT, FURNITURE, FIXTURES, ETC.

26. *Show-window display counters.*—Walls should be of metal or other ratproof material and be snugly fitted to adjoining walls and floor. The top may be of wood, but it should be installed and protected in a ratproof manner.

27. *Store counters for general use.*—These may be of two types, viz., one which is elevated 10 to 12 inches above floor or one that rests on floor but which has no enclosed space at base.

28. *Refrigerating or air-cooled type of counter.*—The bases containing motor units should be effectively closed by metal plates or approved heavy screens.

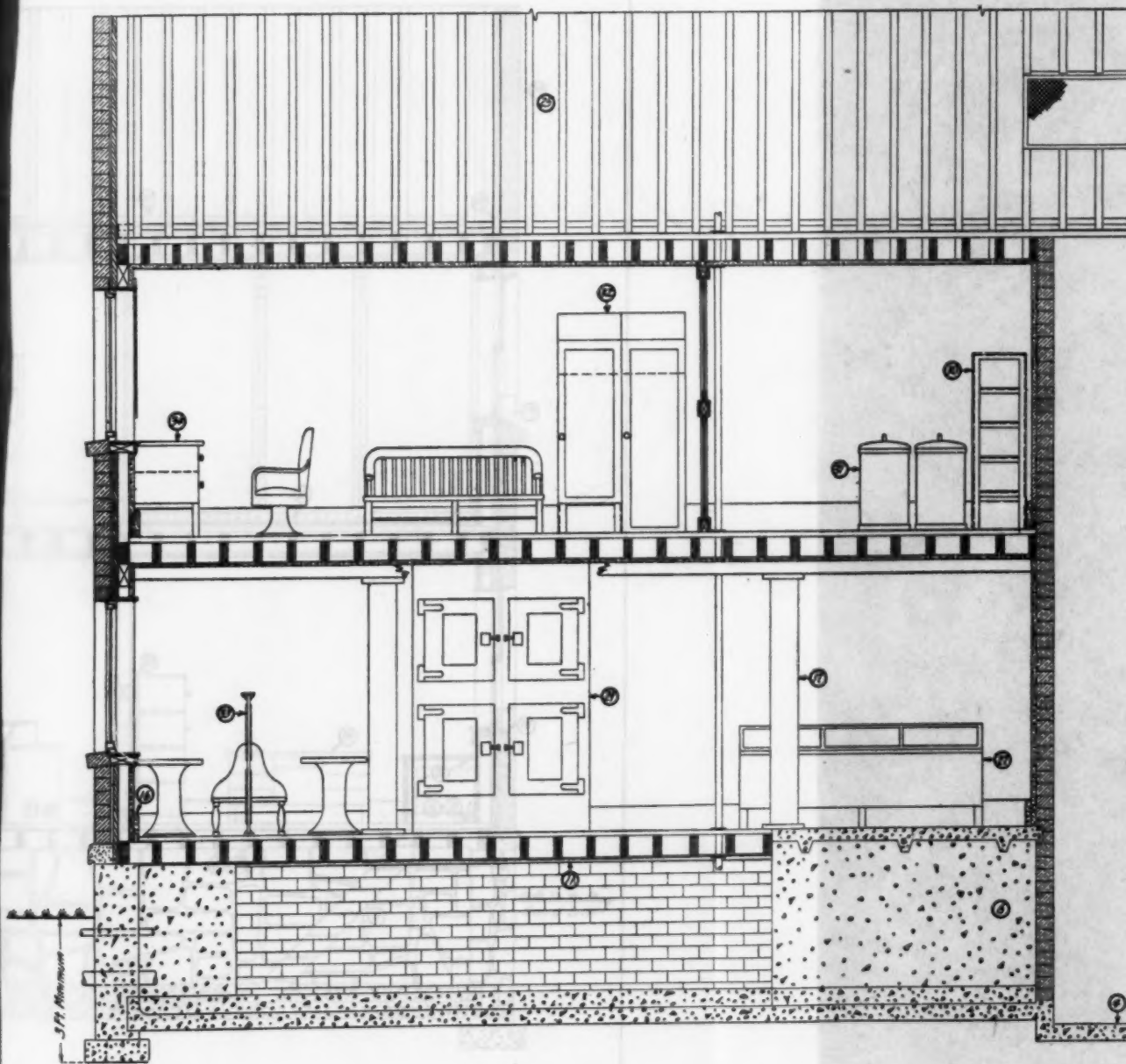
29. *Refrigerators.*—Should preferably be constructed of metal or other ratproof material, should be installed in a waterproof, fireproof, and ratproof base, flush against adjoining walls, and built up to and flush with ceiling. When headroom is such that this is not practicable, the tops of refrigerators should be ratproofed by installing a sloping pyramid top constructed of sheet metal.

30. *Shelving fixtures.*—Should be devoid of enclosed space at the base, and bottom shelves should be installed flush against adjoining walls.

31. *Storage bins of portable type.*—Cylindrical metal cases are fundamentally ratproof and embody other desirable sanitary features. They should be used instead of the old battery type of wooden bins.

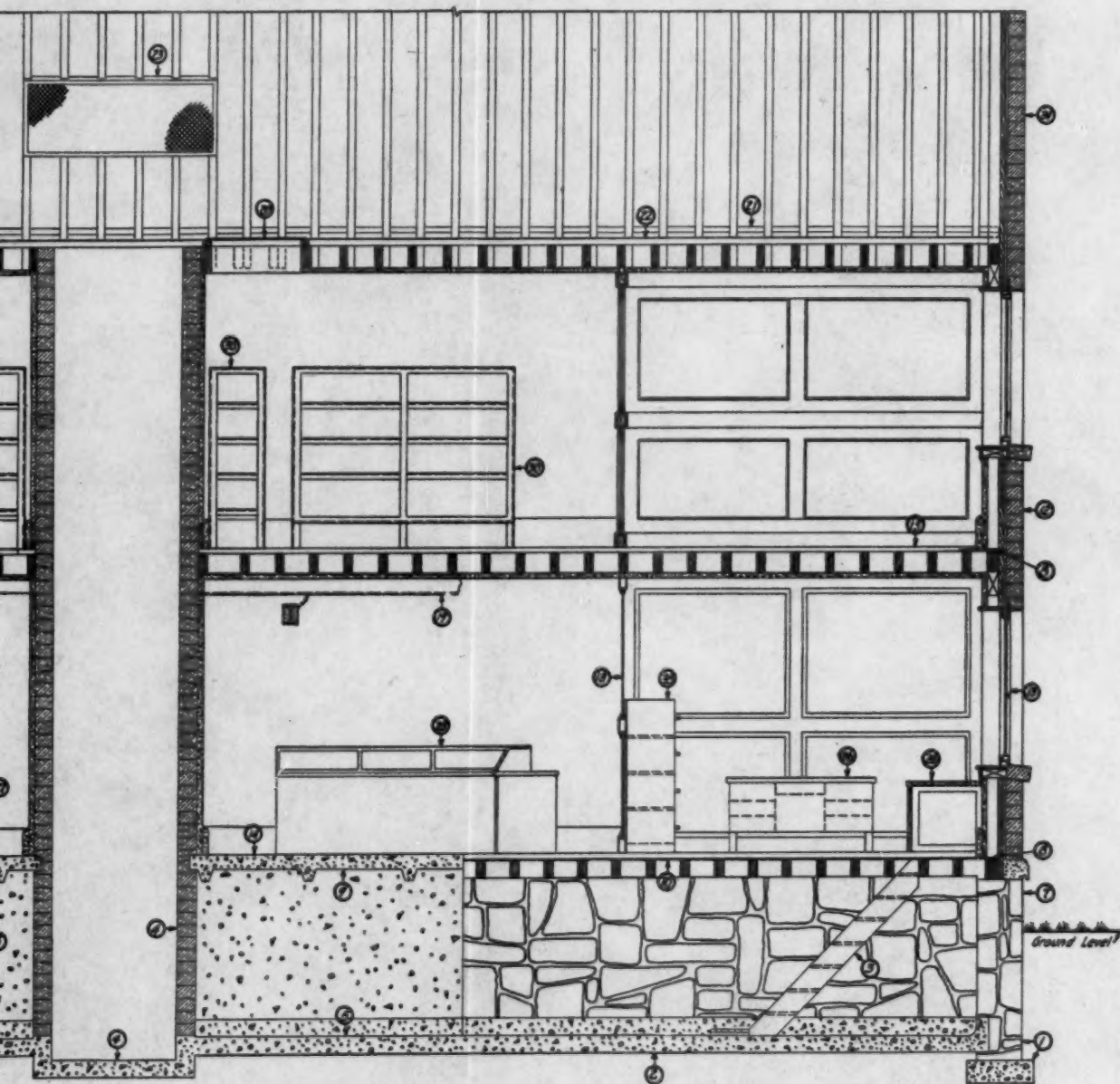






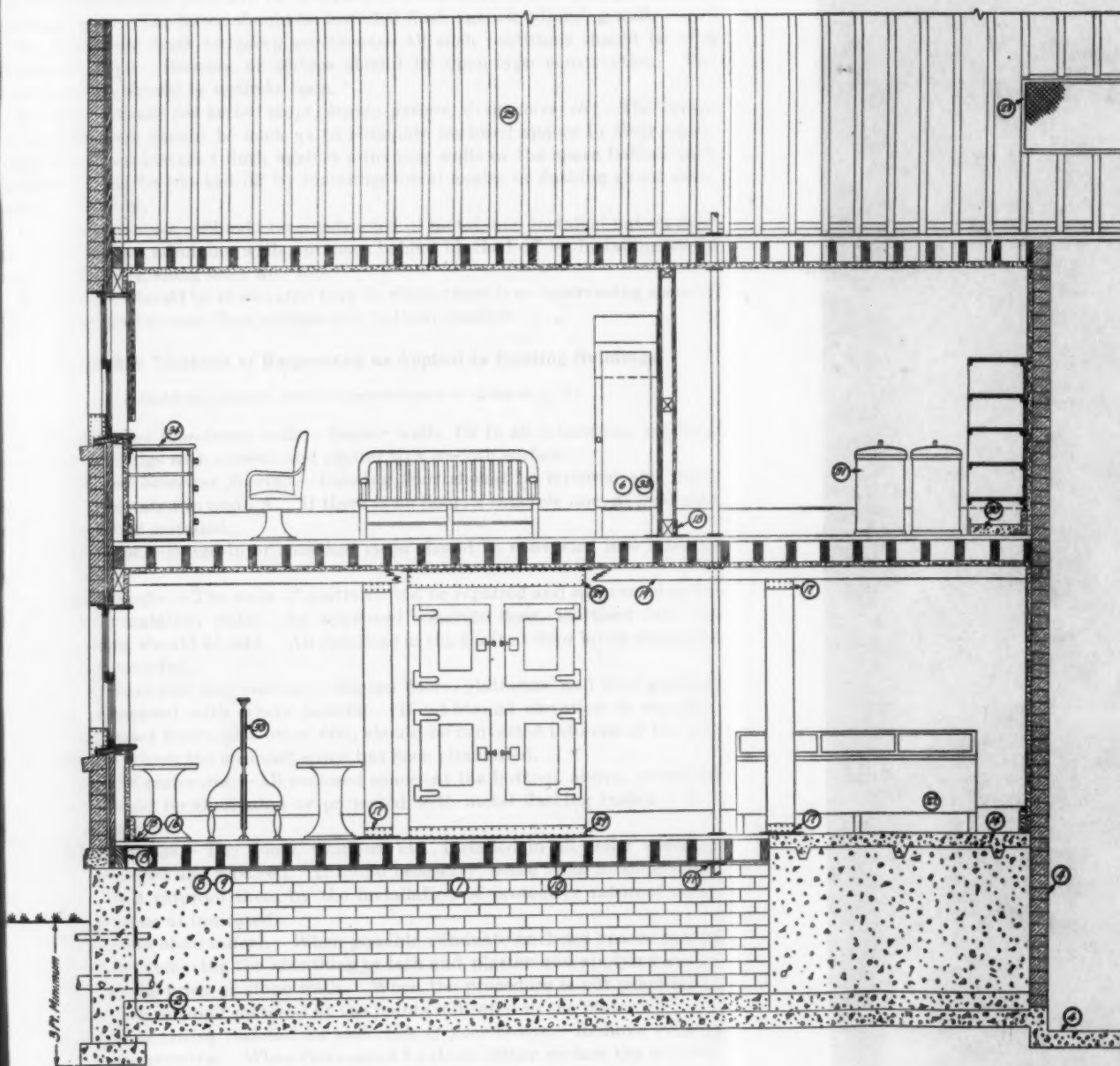
U.S. PUBLIC HEALTH SERVICE  
BATHROOMS OF BUILDINGS

REQUIREMENTS FOR BATHROOMS OF BUILDINGS OF THE PUBLIC HEALTH SERVICE  
AS APPLIED TO BUILDINGS OF THE PUBLIC HEALTH SERVICE

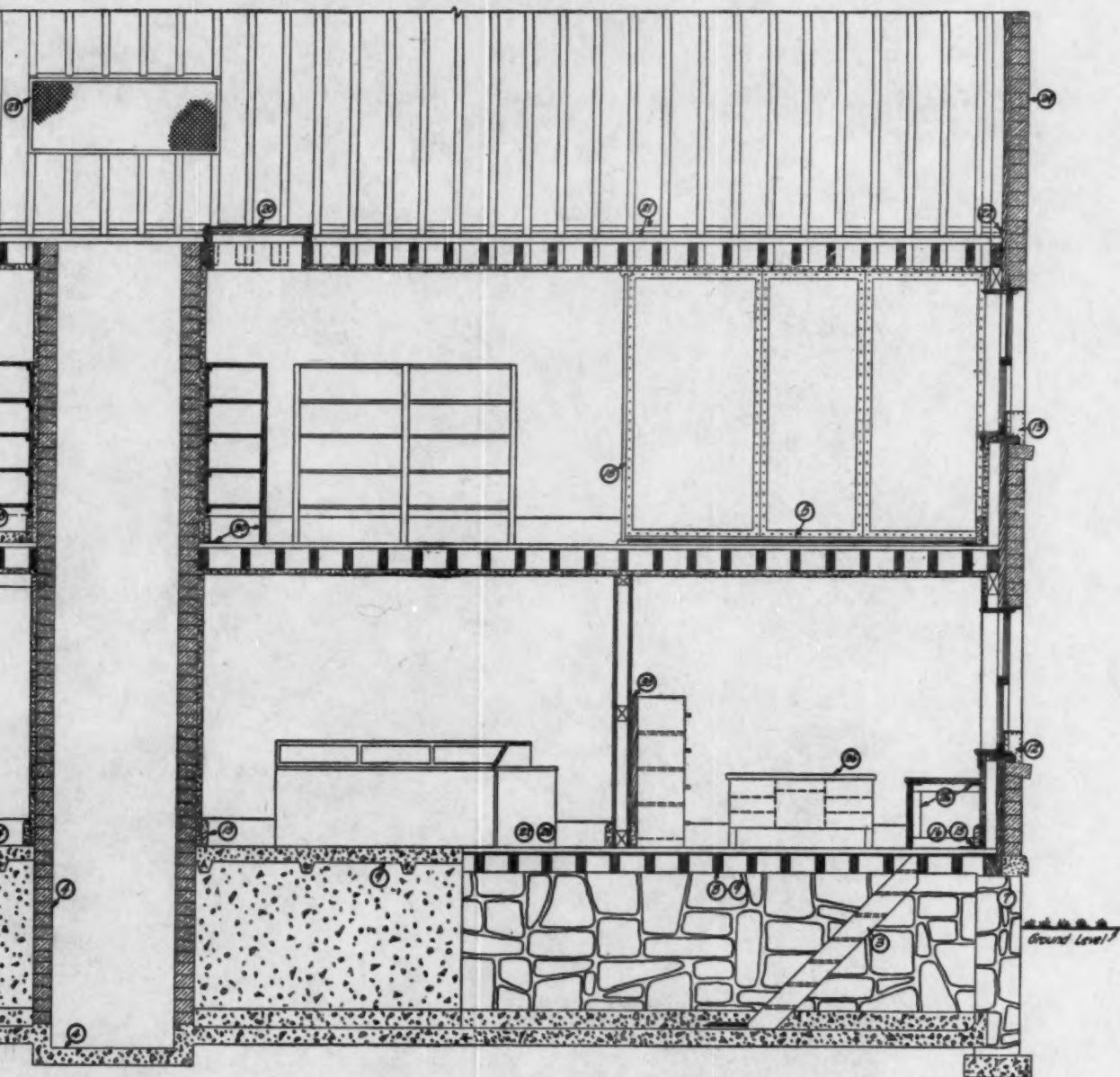


U.S. PUBLIC HEALTH SERVICE  
RATPROOFING OF BUILDINGS

COMPOSITE DRAWING SHOWING HOW FUNDAMENTAL RATPROOFING  
CAN BE ACCOMPLISHED BY DESIGN







U.S. PUBLIC HEALTH SERVICE  
RATPROOFING OF BUILDINGS

ILLUSTRATION OF CORRECTIVE METHODS OF RAT PROOFING  
AS APPLIED TO EXISTING BUILDINGS



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32. *Lockers.*—These may be of two types: (1) With bottom which is elevated 10 to 12 inches from floor and (2) a type which fits flush to floor but is devoid of enclosed base. The latter should be installed flush against adjoining wall.

33. *Restaurant booth boundary partitions.*—All such partitions should be of a single-wall type. Benches or settees should be open-type construction. The space beneath should be entirely open.

34. *Wall cabinets for barber shops, beauty parlors, drug stores, etc.*—The design of these fixtures should be such as to eliminate enclosed spaces in their bases. They should be installed flush against adjoining walls or the space behind such cabinets should be blocked off by installing metal angles or flashing along sides, bottom, and top.

35. *Filing cabinets.*—Should be constructed of metal, and installed flat on floor and flush against adjoining walls, or space behind blocked off by installing metal angles or flashing along sides and top.

36. *Desks.*—Should be of elevated type in which there is an intervening space of 10 to 12 inches between floor surface and bottom drawers.

### Corrective Methods of Ratproofing as Applied to Existing Buildings

(Identifying numbers refer to numbers shown in circles on pl. B)

1. *Footings and foundation walls.*—Repair walls, fill in all interstices, crevices, and other openings with cement and plaster to a smooth surface.

2. *Cellar and basement flooring.*—Existing floor should be repaired and made ratproof as indicated in plate A. If there is no floor, a concrete one, as indicated above, should be installed.

3. *Cellar steps.*—Boxed-in or sheathed steps should be converted into those of an open type.

4. *Elevator shafts.*—The walls of shafts should be repaired and ratproofed as indicated for foundation walls. An approved concrete floor, mortised into the adjoining walls, should be laid. All openings in the shaft at floor levels should be closed and ratproofed.

5. *Raised floors and floor gratings.*—Raised floors, platforms, and floor gratings should be dispensed with where possible. If additional elevation is required, the existing raised floors, platforms, etc., should be converted into one of the ratproof types in which the enclosed space has been eliminated.

6. *Closets and enclosures.*—All enclosed spaces at the bottom, above, or behind such units should be eliminated or protected with metal flashing installed in a ratproof manner.

7. *Cellar openings.*—The doors, windows, etc., installed in all cellar openings should be inspected and repaired. If found necessary, make them fit snugly into the frames, then ratproof them by the installation of protective ratproof metal flashing or screens as indicated.

8. *Double walls above cellars.*—When possible eliminate enclosed spaces behind double walls, by removing the sheathing or lath and plaster and applying a plastered finish to the brick or stone walls. When the procedure is not practicable, install protective ratproof material at the points indicated in the plates.

9. *Sheathing or ceiling installed on underside of floor beams.*—Remove existing sheathing where possible. When this cannot be done, either replace the non-ratproof ceiling with material that is impervious to gnawing by rats, and install it in a snug-fitting ratproof manner, or repair the old ceiling and install metal flashing, metal collars, etc., at all gnawing edges, as indicated in the tabulation and the plates.

10. *Sheathing installed under floor beams or rafters for fire-deterrent purposes.*—Replace existing sheathing with the approved ratproof type, which should be installed flush against the underside of the floor and flat against the sides of the floor beams or rafters.

11. *Ceiling under floor beams.*—When ceiling made of fire-deterrent material is installed under the floor beams and it is not practicable to remove it and reinstall it as suggested above, it should be ratproofed as indicated in 9, pl. B.

12. *Structural walls above foundation.*—Repair and fill in all broken places and openings around pipes and other feed lines, around door and window frames, etc. Install protective ratproof metal flashing or other material wherever required to prevent access to enclosed spaces.

13. *Doors, windows, and other openings.*—All doors, windows, etc., of existing buildings should be repaired, made tight fitting, and then ratproofed as indicated. Particular attention should be paid to door sills and the bottoms of doors.

14. *Main floor.*—Existing floors should be repaired to make them intact and then ratproofed as indicated.

15. *Floors constructed of wood.*—Existing wooden floors should be repaired and ratproofed by the installation of metal flashing, metal collars, etc., at all gnawing edges as indicated in the tabulation and plates.

16. *Base boards or mop boards.*—Metal flashing strips should be installed along the exposed edges exposed to gnawing by rats.

17. *Structural pillars.*—The sheathing should be removed from boxed-in pillars, if practicable. If not, the sheathing or casing should be metal flashed at the bottom and top, as indicated.

18. *Partition walls.*—Existing partition walls, if of double construction, should be ratproofed by the installation of protective metal flashing, etc., at points indicated. When practicable, double walls in commercial establishments should be converted into solid single walls.

19. *Insulated and boxed beams.*—If approved ratproof material has not been employed in covering or boxing the beams, metal strips should be installed at all points where gnawing and invasion by rats is possible.

20. *Trap doors to attic.*—Such doors should be repaired, made to fit snugly in frames, and hinged to same. Both the frame and the door, if constructed of wood, should be ratproofed by the installation of metal strips or flashing. It is desirable that the trap door be constructed of metal or be metal sheathed.

21. *Open spaces over wall plate between roof rafters at eaves.*—In existing buildings, perforated metal plates or an approved type of wire screen should be installed over such openings.

22. *Attic flooring.*—Flooring in attics should be well fitted, installed in a permanent manner, and ratproofed by installing protective material around all gnawing edges.

23. *Skylights.*—Existing skylights should be repaired, made to fit snugly in the frames, and the gnawing surfaces of both be protected by the installation of metal flashing.

24. *Outlets for electric and telephone service lines.*—The openings in the walls through which these lines pass should be closed by the installation of metal collars or cement fill.

25. *Roofs (attic space).*—Boxes, bins, or other units with enclosed spaces which furnish harborage should be removed or made ratproof.

26. *Show windows with display counters.*—Protective ratproofing material should be installed on the outside wall, below the window, over the ventilating openings, and along all gnawing edges of the wooden display counter installed on the inside of the window.

27. *Store counters.*—Eliminate harborage in existing fixtures by removing boxed-in bases or lower sections.

28. *Refrigerating or air-cooled counters.*—Protect enclosed harborage at base by installing perforated metal plates over all openings.

29. *Refrigerators.*—Old type of wooden refrigerators installed in existing buildings should be made ratproof by installing protective metal flashing strips at bottoms and sides. The tops should be treated as indicated in tabulation.

30. *Shelving fixtures.*—Existing shelving fixtures should be ratproofed by eliminating the harborage in the boxed-in lower shelf or protecting it with metal so that invasion is made impossible. Shelving should be installed in the ratproof manner indicated.

31. *Bins.*—Existing wooden bins of the type generally used in stores, should be repaired and the enclosed spaces at the bottom eliminated. The bins should be metal lined and elevated from the floor or set in a ratproof and sanitary base. Harborage spaces between the walls and the bins should be eliminated or protected.

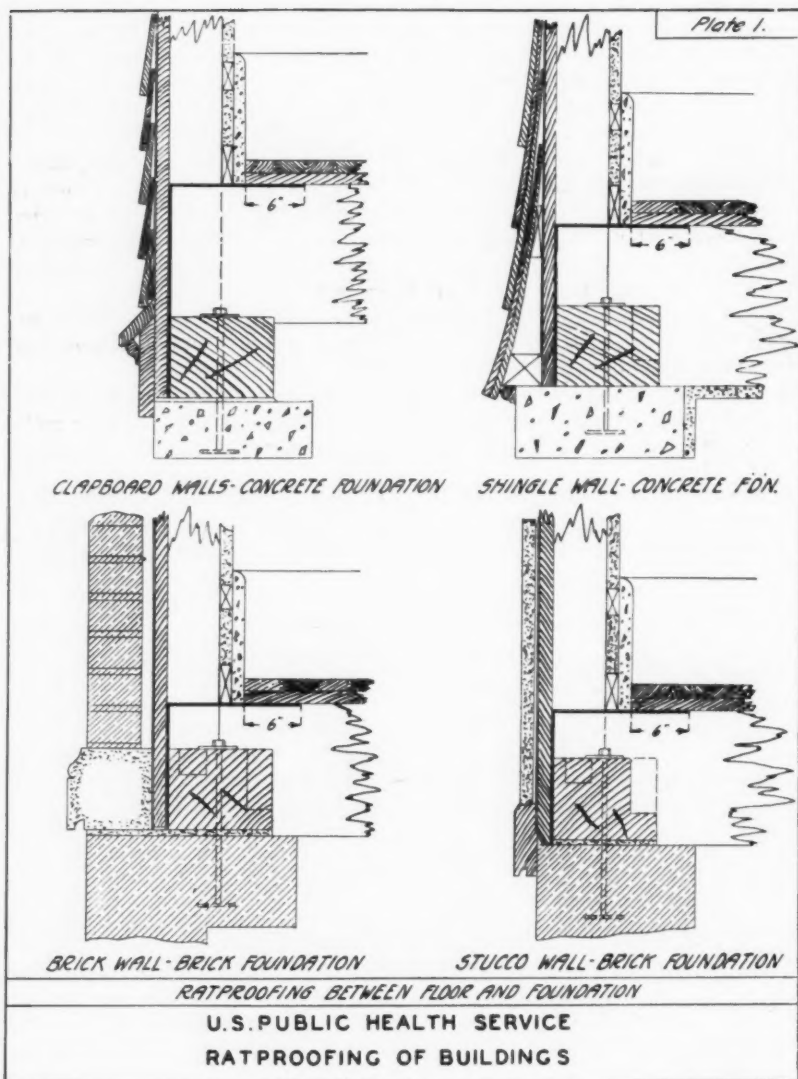
32. *Lockers.*—Existing lockers should be ratproofed in the manner described above, except that the metal lining is not required.

33. *Restaurant booth boundary partitions.*—Convert double-wall partitions into those of a single-wall type where possible; otherwise protect harborage as required for double wall spaces.

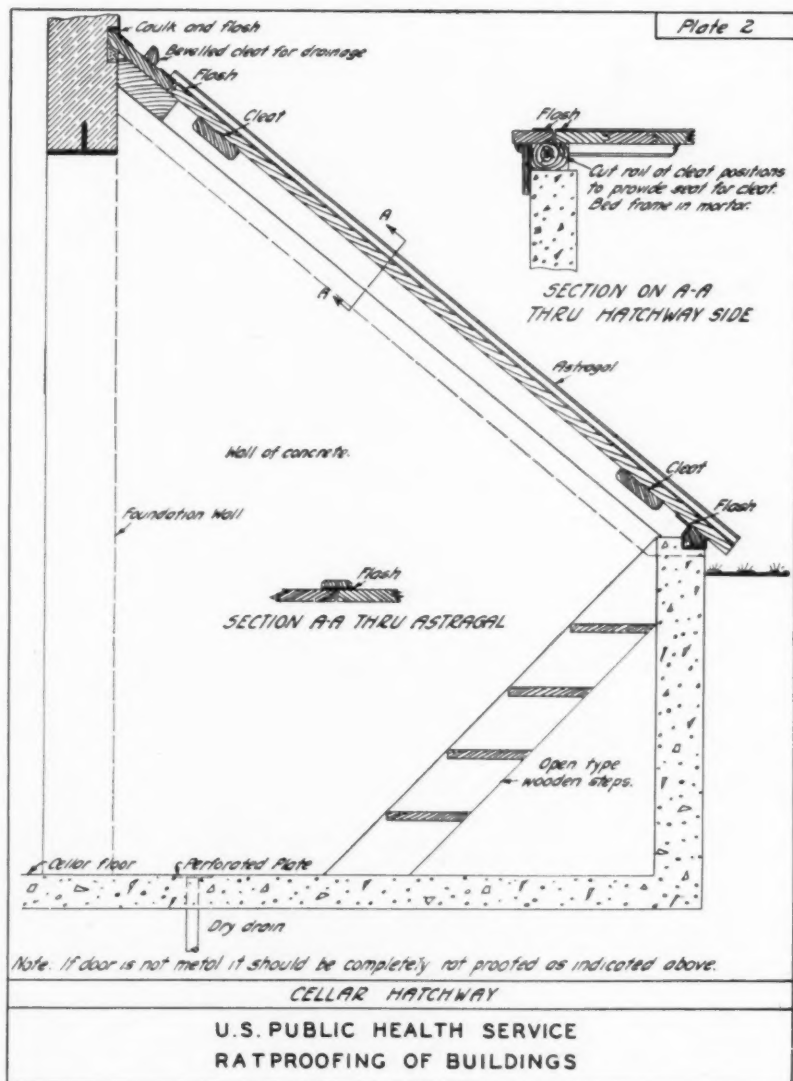
34. *Wall cabinets, etc.*—Eliminate enclosed spaces in bases. Install fixtures flush against wall or close intervening space along sides and over top with metal flashing strips. Install metal flashing along the lower edges of the fixtures to prevent gnawing.

35. *Filing cabinets.*—Ratproof existing filing cabinets as previously indicated.

36. *Desks.*—The old wooden type of desk should be discarded for a sanitary ratproof type. If this cannot be done, it should be ratproofed as indicated in the tabulation.







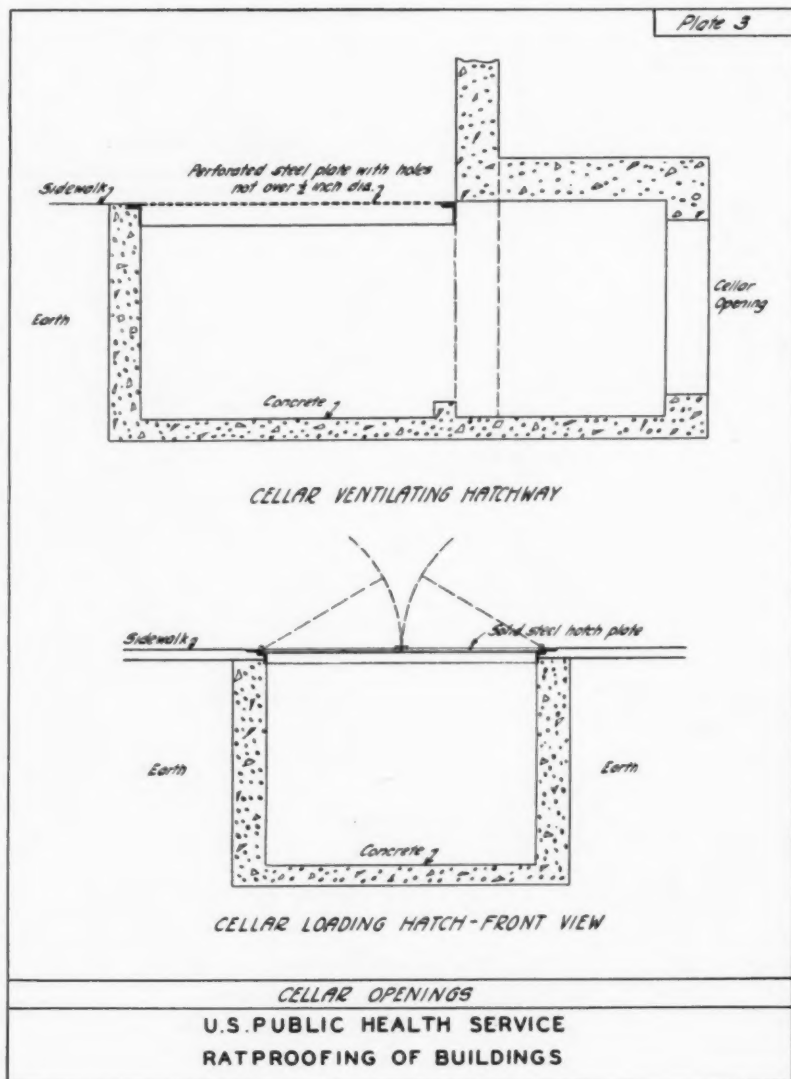
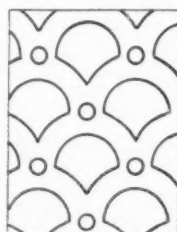
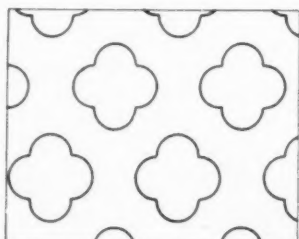
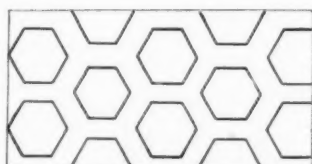
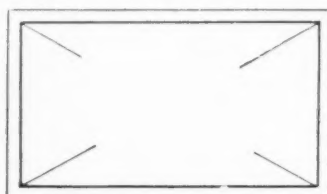
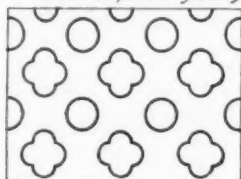


Plate 4



*Note: If openings consist of horizontal or vertical louvre slots the openings should not be greater than  $\frac{1}{8}$  inches width if wood framing is installed in or around cellar openings it should be metal covered to prevent gnawing.*



*Strong solid metal frame for grilles*

*NOTE: No opening greater than  $\frac{1}{8}$  inch. If grille openings exceed  $\frac{1}{8}$  inch install perforated plate on interior face of grille.*

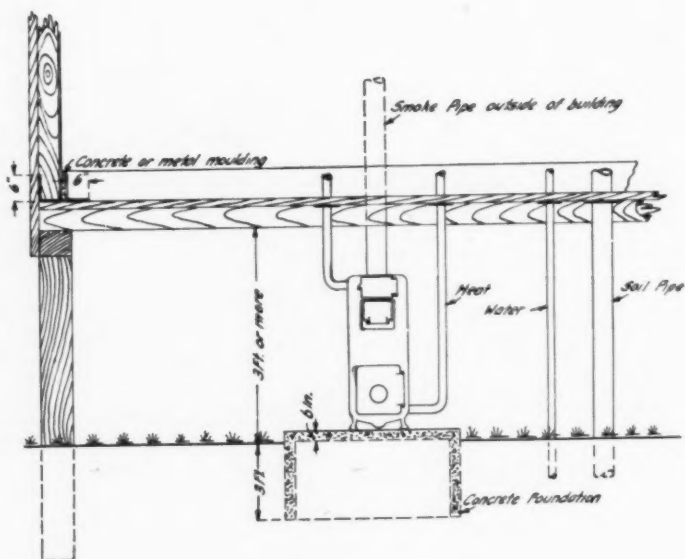
#### DECORATIVE GRILLES

U.S. PUBLIC HEALTH SERVICE  
RATPROOFING OF BUILDINGS

Plate 5

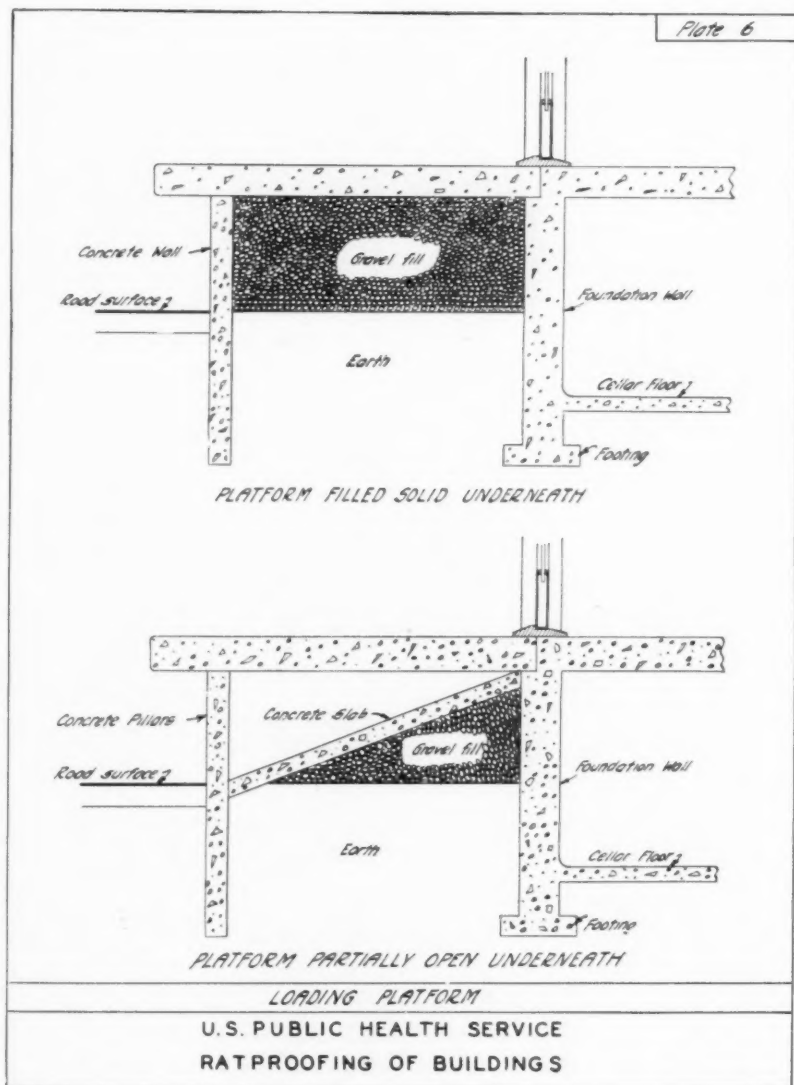
Harborage is to be found in and around:

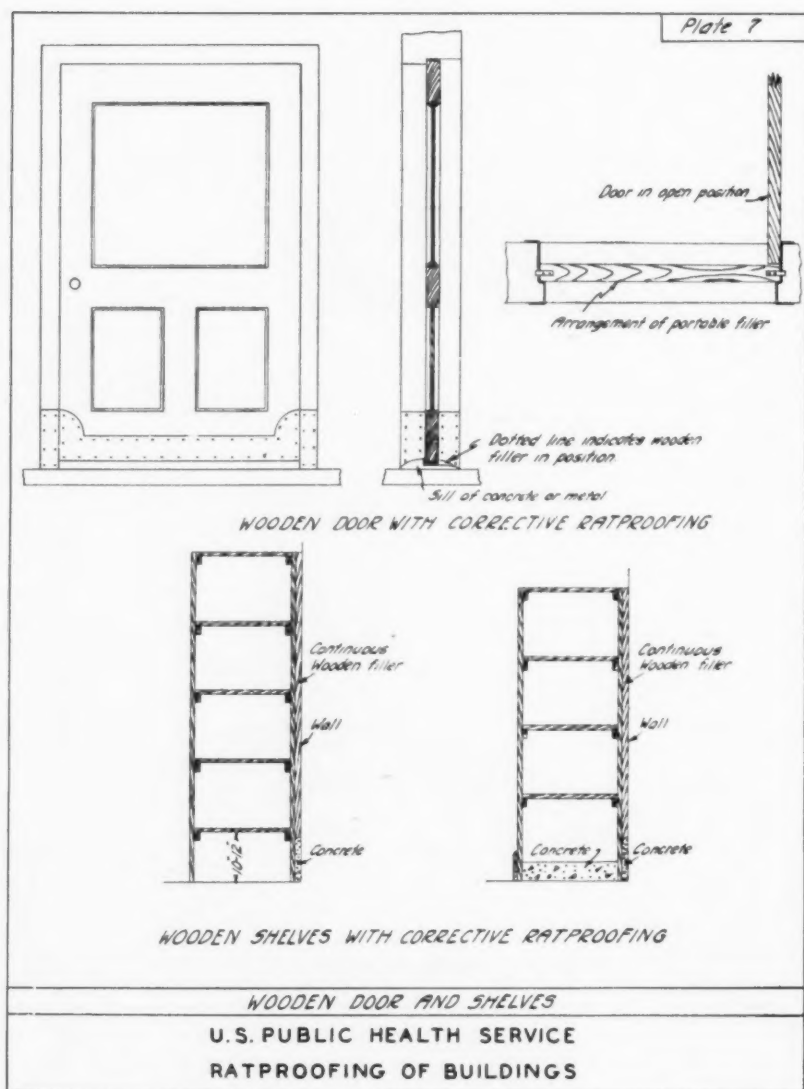
1. Concrete foundation under heater
2. Base of heater
3. Supply and discharge pipes piercing floor or wall.



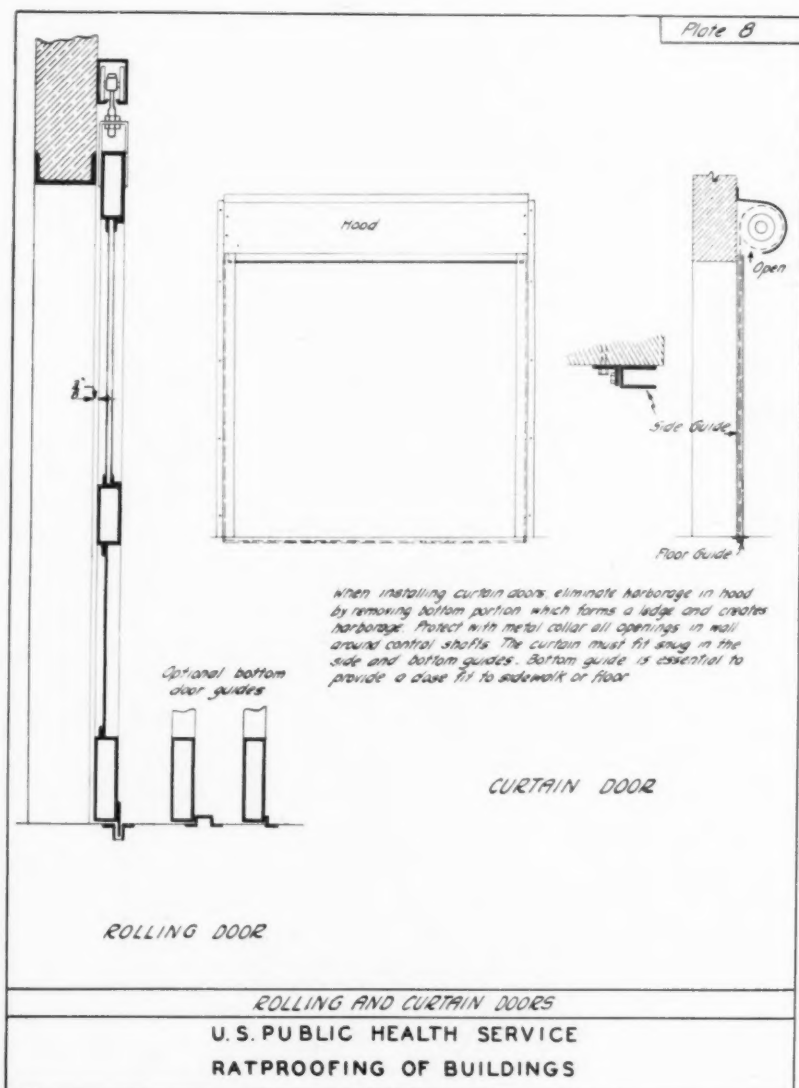
#### BUILDINGS ON PILES

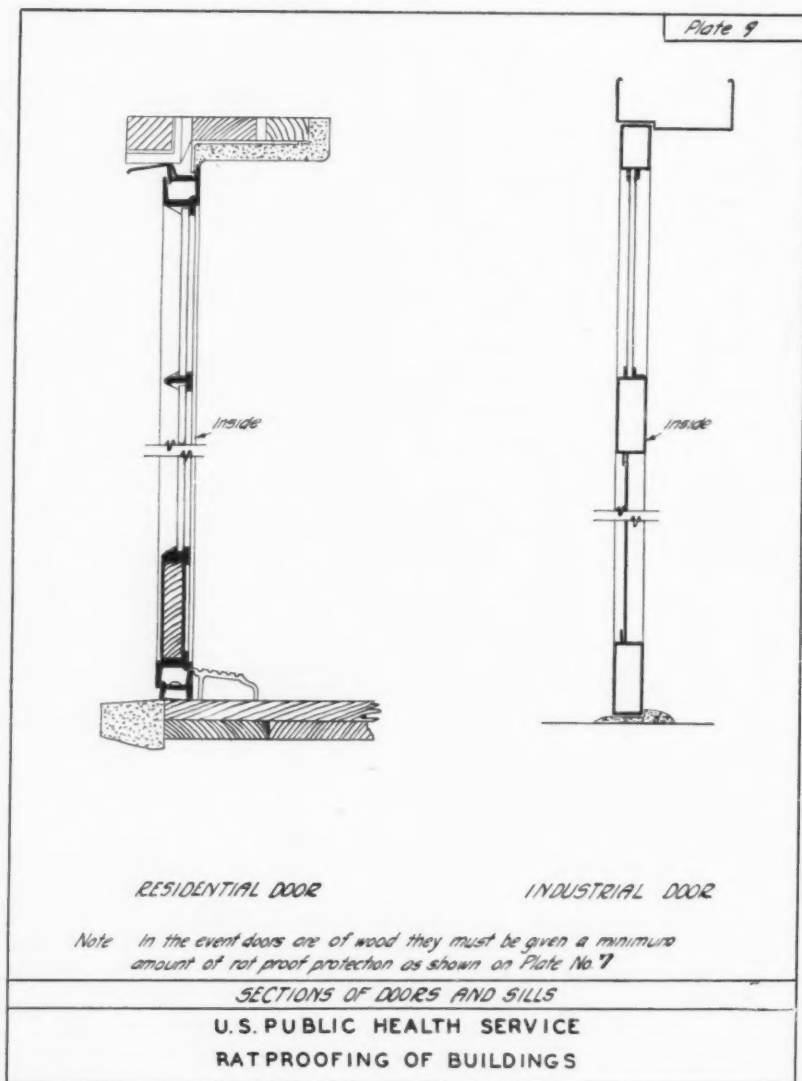
U.S. PUBLIC HEALTH SERVICE  
RATPROOFING OF BUILDINGS

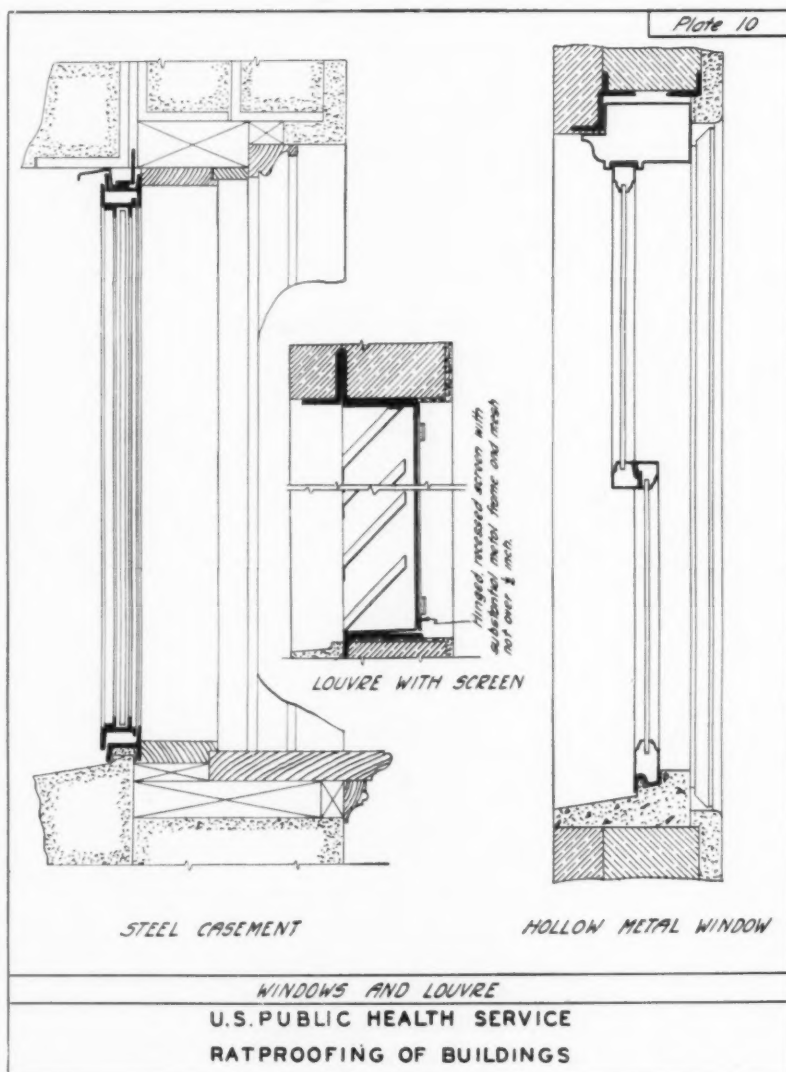












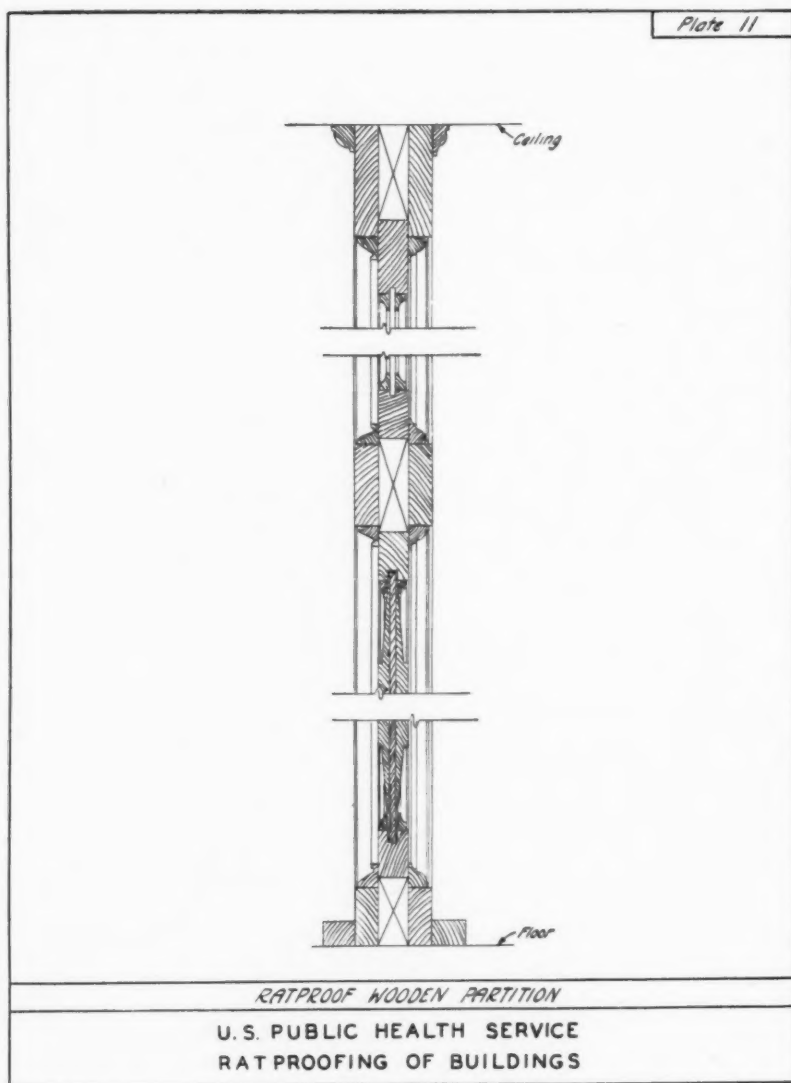
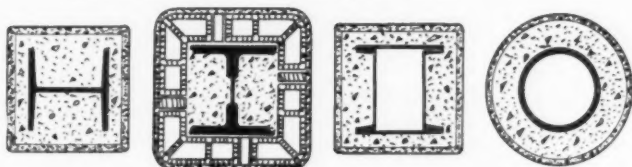
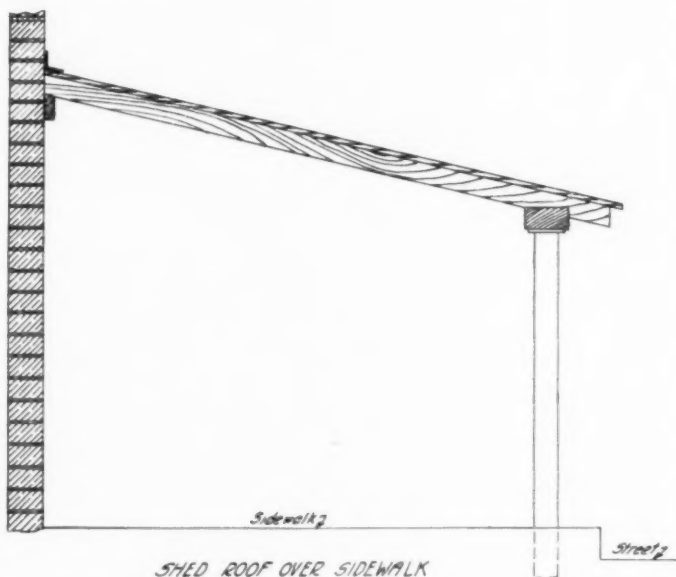


Plate 12

*Note: If columns are of the open steel type, whether single or double bottom, pyramid up with concrete or base in basom for 12 to 14 inches above floor at not less than 45 degrees thereto.*



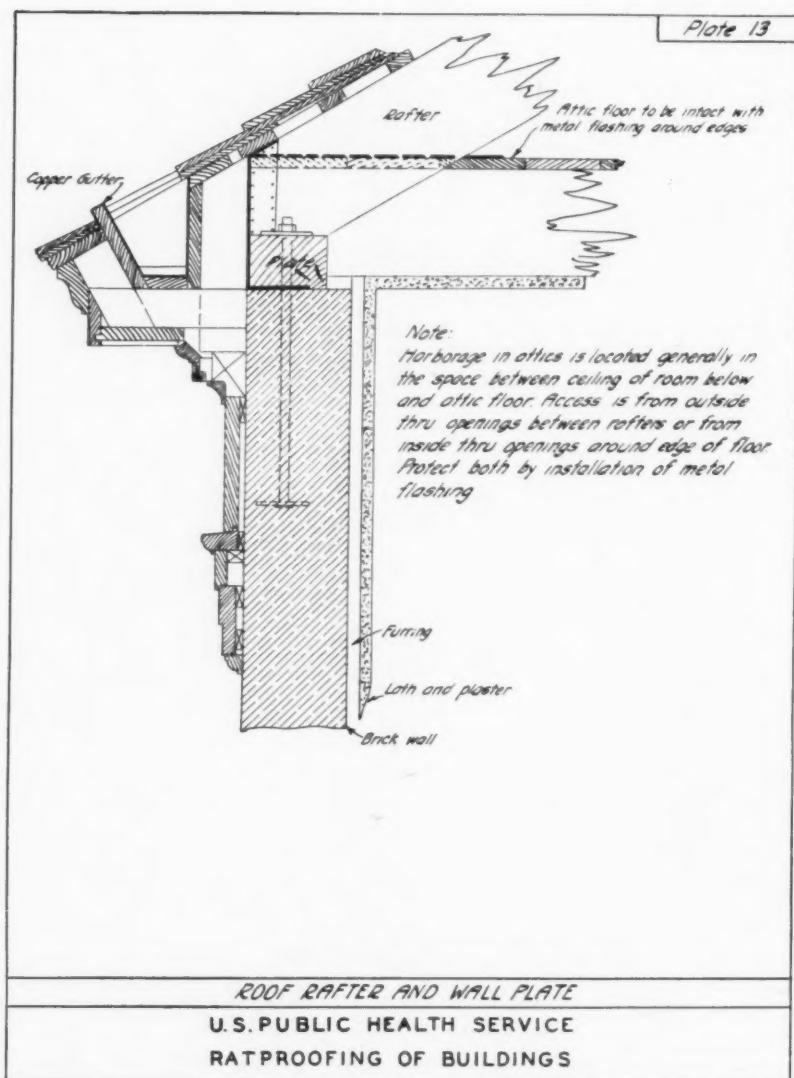
SECTIONS OF VARIOUS TYPES OF RATPROOF COLUMNS



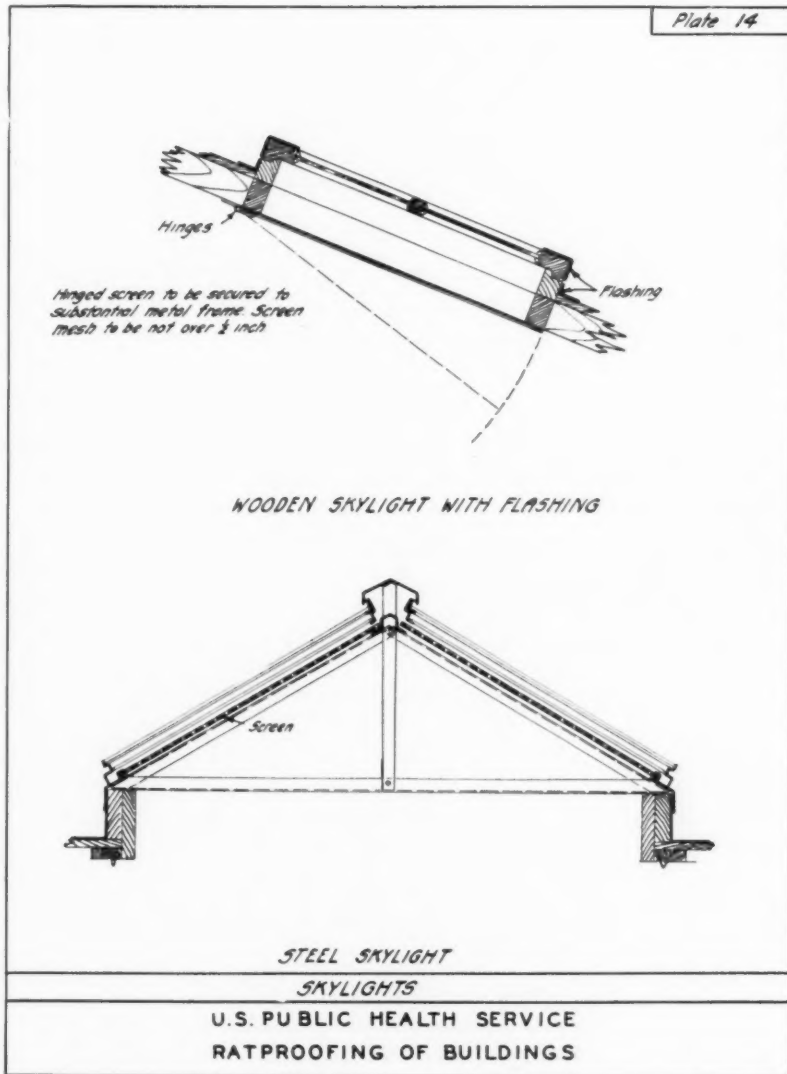
SHED ROOF OVER SIDEWALK

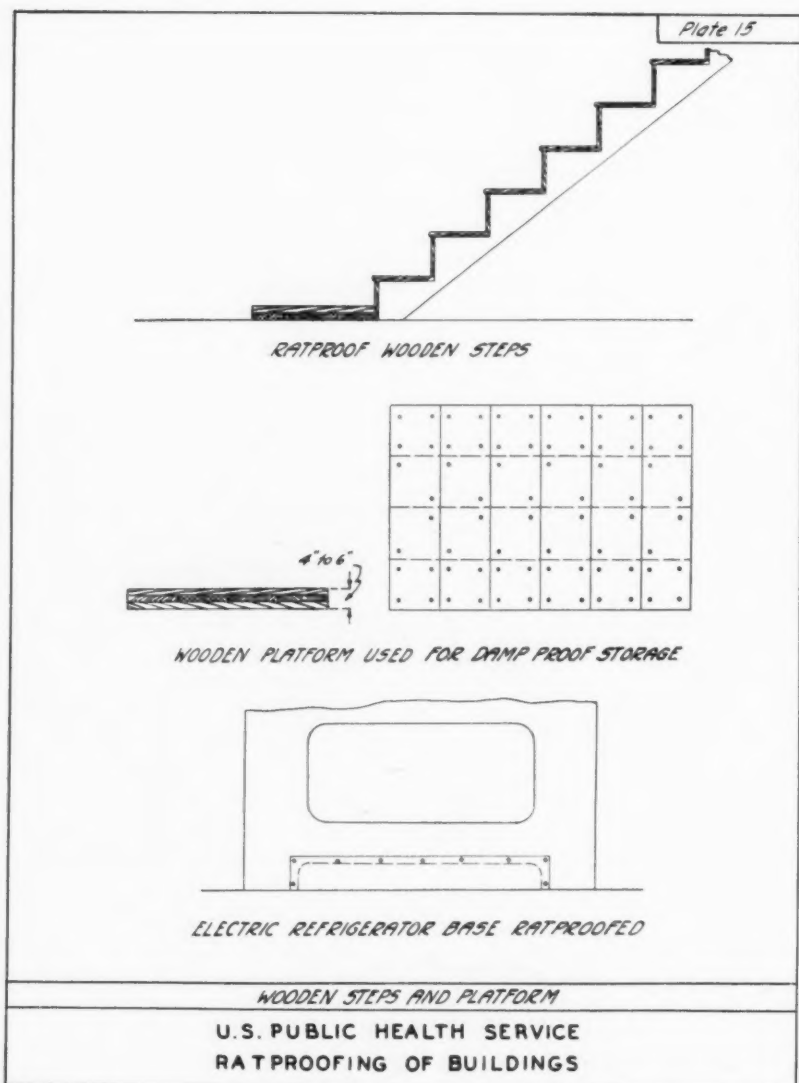
RATPROOF COLUMNS AND SHED ROOF OVER SIDEWALK

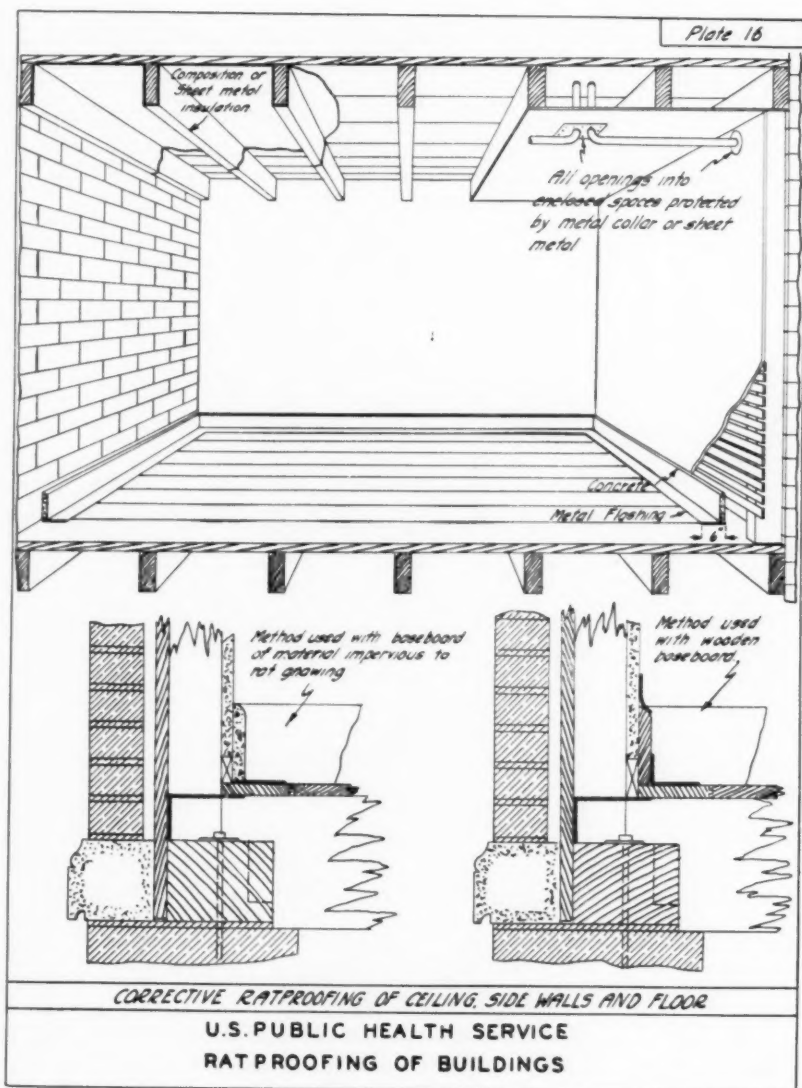
U.S. PUBLIC HEALTH SERVICE  
RATPROOFING OF BUILDINGS

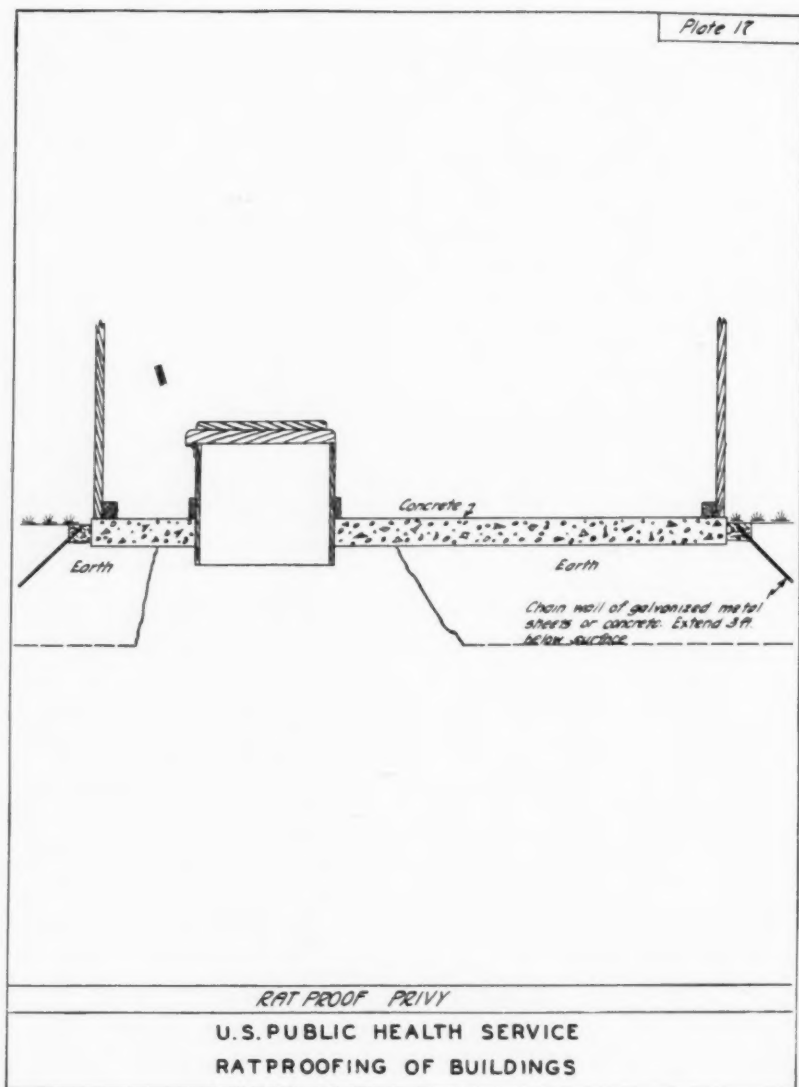


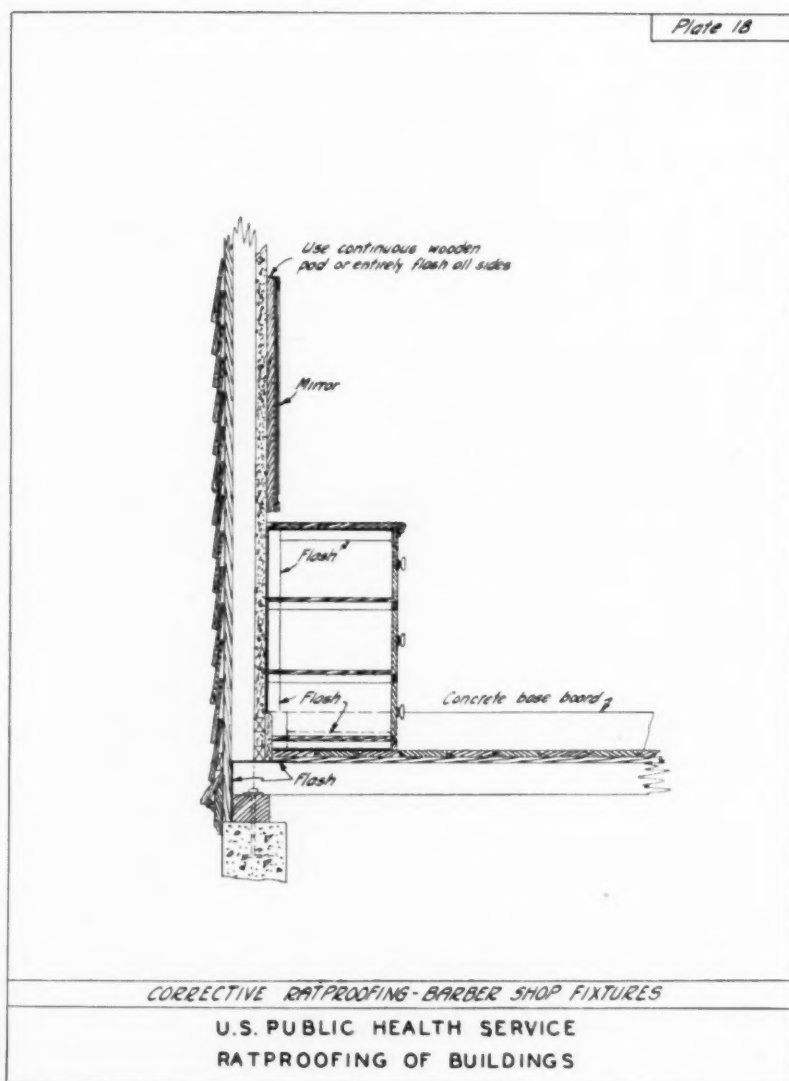


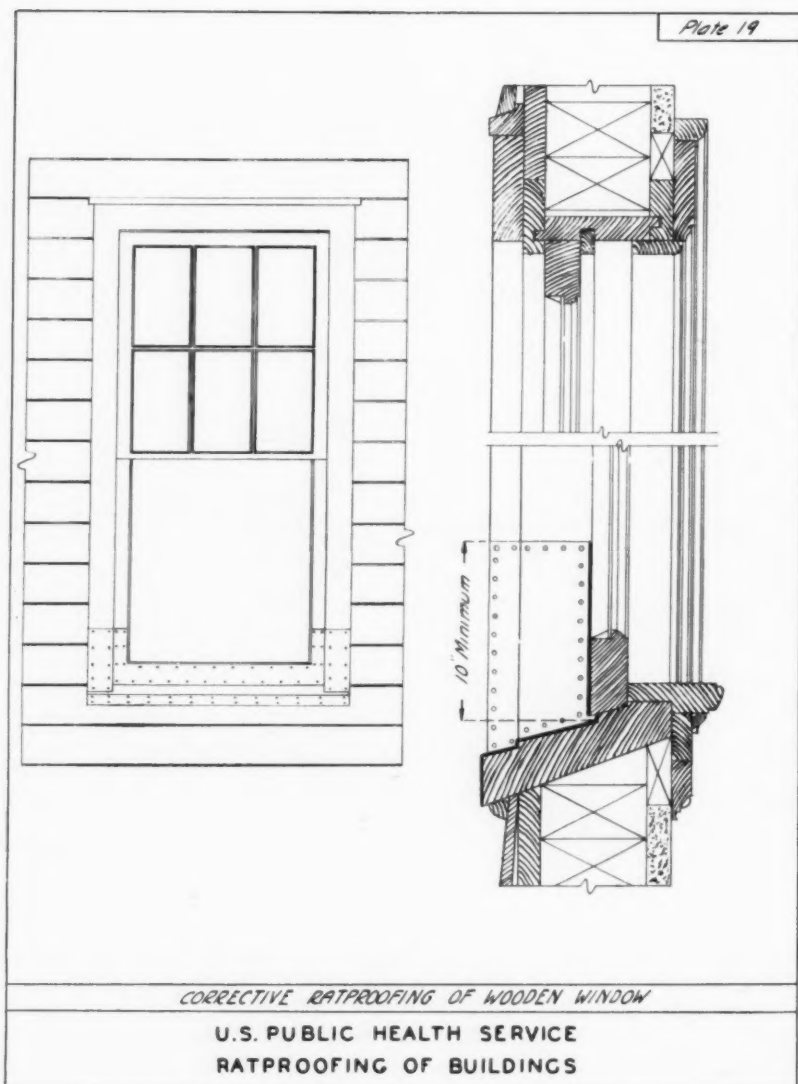




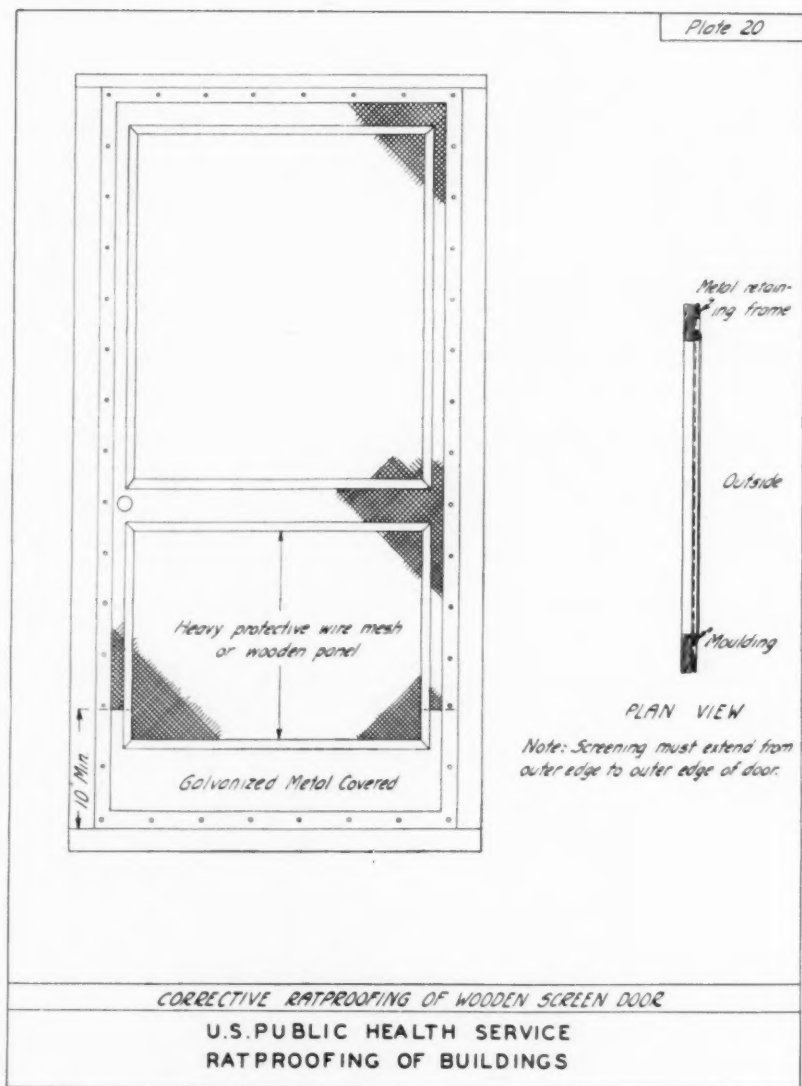


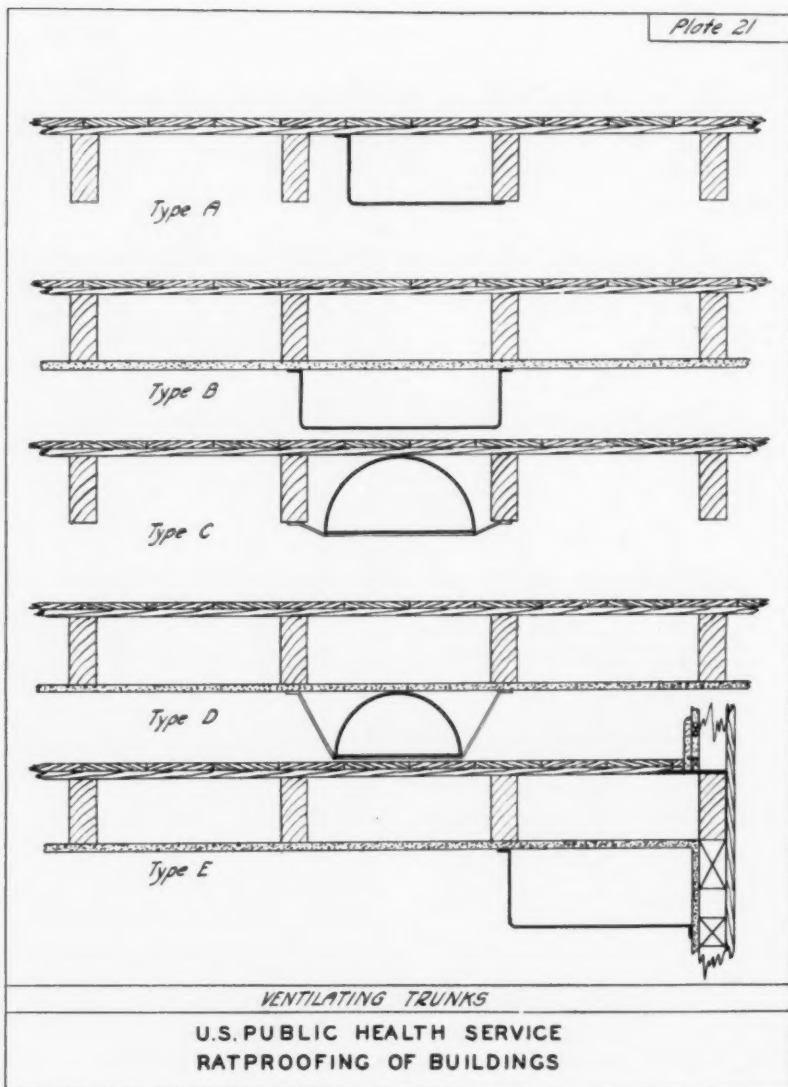










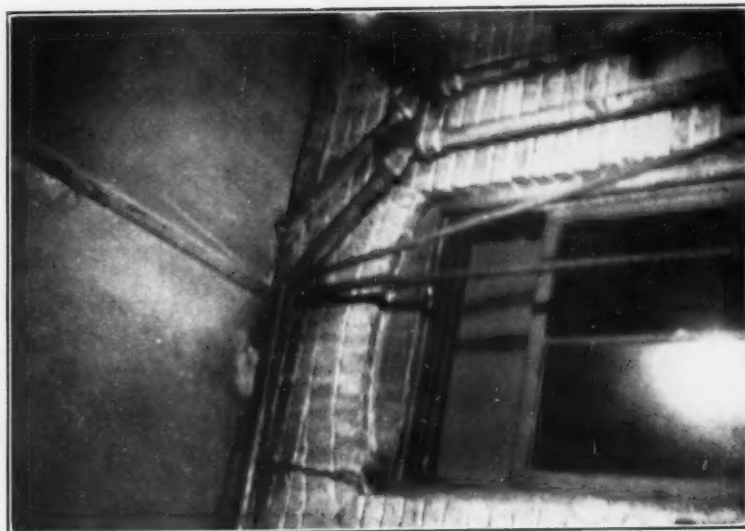




STRUCTURAL HARBORAGE. CONDITIONS FOUND IN SOME CELLARS. RAT HOLES WHICH LEAD TO HOMES AND NESTS BUILT IN THE INTERSTICES OF STONE OR BRICK FOUNDATION WALLS OF BUILDINGS.



STRUCTURAL HARBORAGE. EXAMPLE OF STRUCTURAL HARBORAGE LOCATED IN THE ENCLOSED SPACE BETWEEN DOUBLE WALLS. NOTE THE NESTING MATERIAL INSTALLED BEHIND THE BASEBOARD.



STRUCTURAL HARBORAGE. TYPICAL EXAMPLE OF RAT HARBORAGE IN ENCLOSED SPACE ABOVE CEILING. PIPE LINES AND OPENINGS IN SHEATHING THROUGH WHICH PIPES PASS FURNISH THE MEANS OF APPROACH AND OPPORTUNITY FOR ENTRY TO THIS TYPE OF HARBORAGE.



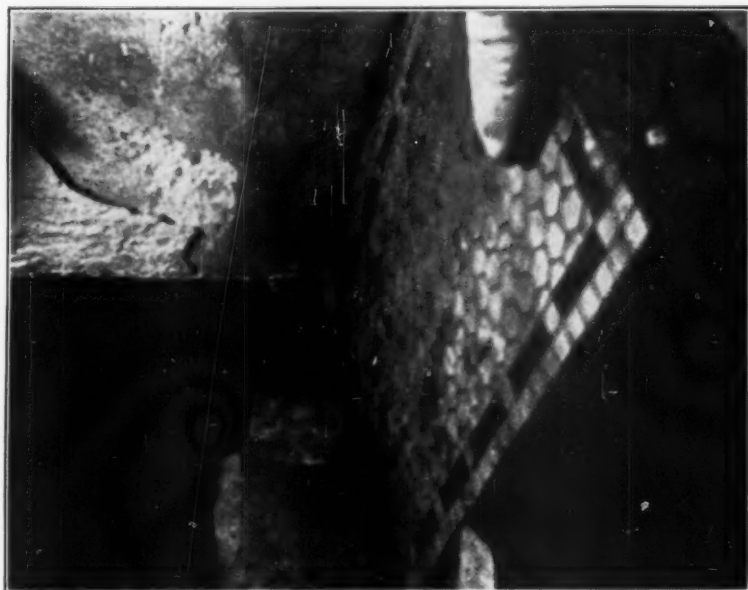
STRUCTURAL HARBORAGE. CELLAR OF POULTRY MARKET, SHOWING ENTRANCE TO THE RAT HARBORAGE BENEATH A RAISED FLOOR INSTALLED IN A CLOSET.

OPENINGS IN SHEATHING THROUGH WHICH  
PIPES PASS FURNISH THE MEANS OF AP-  
PROACH AND OPPORTUNITY FOR ENTRY  
TO THIS TYPE OF HARBORAGE.

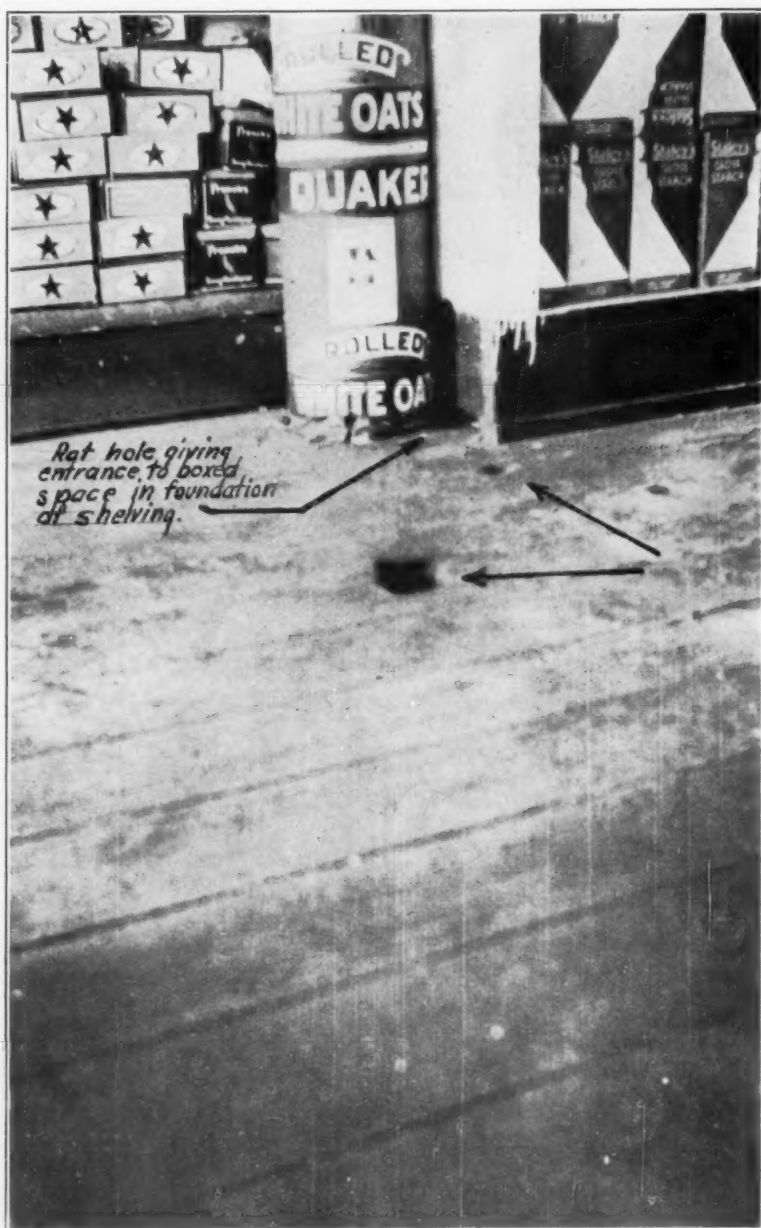
BEVERLY H. WAINSLY, LOOKING INSIDE  
IN A CLOSET.



STRUCTURAL HARBORAGE. EXAMPLE OF DEFECTS IN CONSTRUCTION OF EXTERIOR WALLS. RATS USE SUCH OPENINGS TO GAIN ACCESS TO BUILDINGS.

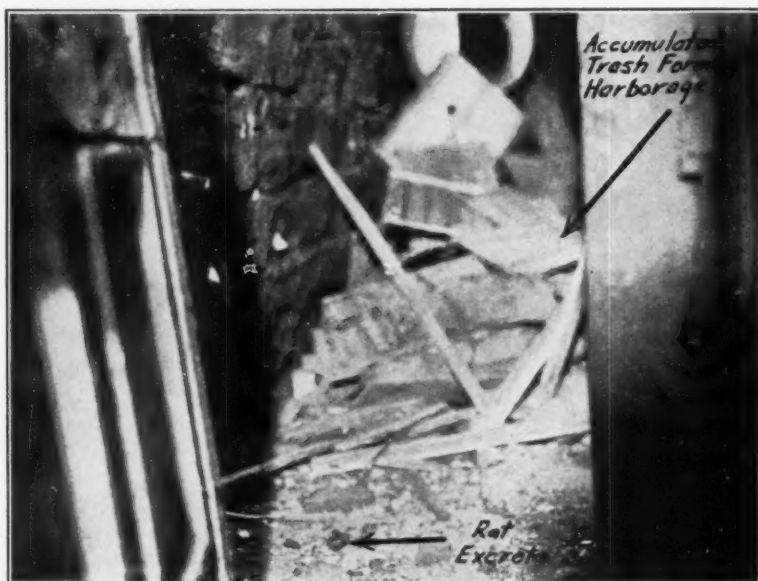


INCIDENTAL HARBORAGE. NOTE RAT HOLE WHICH HAD BEEN GNAWED IN THE CORNER OF THIS BOXED-IN LOWER SECTION OF SHELVING FIXTURE. THIS OPENING HAD BEEN USED EXTENSIVELY BY RATS.



BOTTOM SECTION OF A TYPICAL SHELVING FIXTURE INSTALLED IN A STORE. THE HARBORAGE IS CONTAINED IN THE BOXED-IN LOWER SHELF. NOTE OPENING THROUGH WHICH RATS GAIN ACCESS TO SAME.





TEMPORARY HARBORAGE. A CONDITION VERY TYPICAL OF WHAT MAY BE FOUND IN MANY CELLARS AND BASEMENTS OF BUILDINGS THROUGHOUT THE COUNTRY.



STRUCTURAL HARBORAGE. DEFECTS IN OUTSIDE WALL WHICH PERMIT EASY INVASION OF BUILDING BY RATS. EXAMPLE OF TEMPORARY HARBORAGE IN A RUBBISH PILE IS ALSO SHOWN.

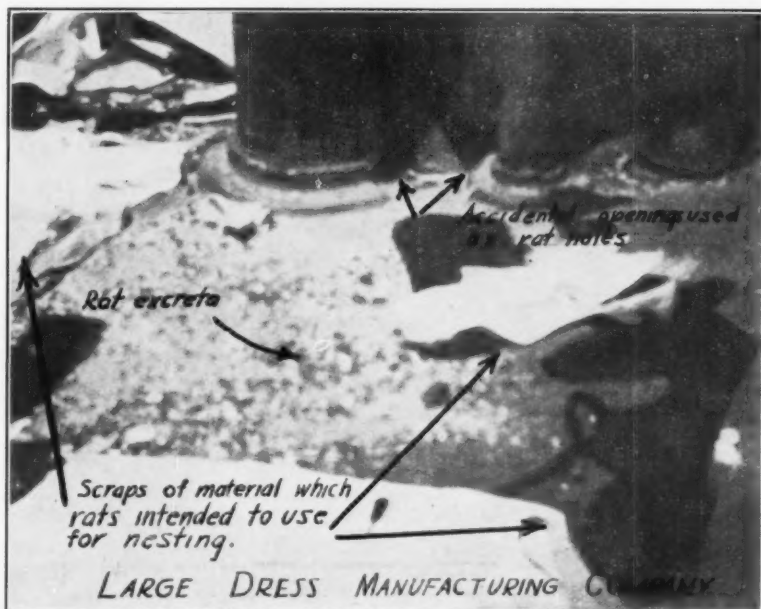


STRUCTURAL HARBORAGE. THE LINING OF THE UNDERSIDE OF FLOOR BEAMS, IN CELLARS OR BASEMENTS, RESULTS IN THE FORMATION OF RAT HARBORAGE CONDITIONS SIMILAR TO THOSE SHOWN ABOVE.



STRUCTURAL HARBORAGE. SHOWS HOW OPENINGS MADE IN FLOOR FOR THE PASSAGE OF ROPES OF ELEVATOR HAD BEEN USED BY RATS TO GAIN ACCESS TO THE SPACE BETWEEN FLOOR AND CEILING.

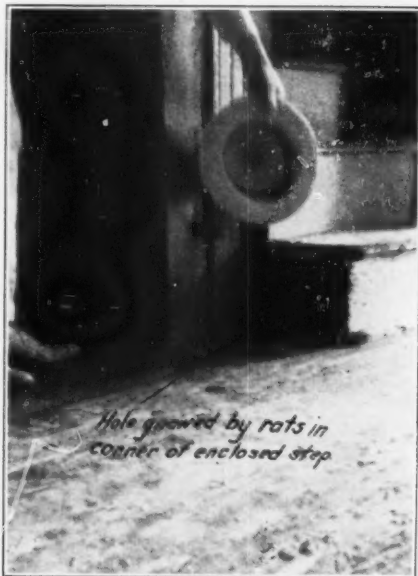
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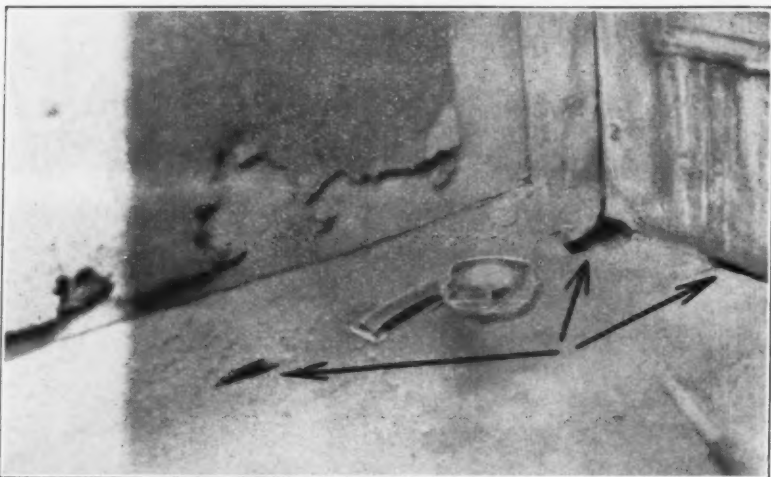
STRUCTURAL HARBORAGE. TYPE OF OPENINGS IN FLOORS AROUND STRUCTURAL COLUMNS AND PIPE LINES WHICH PERMIT RATS TO GAIN ACCESS TO THE ENCLOSED SPACE BENEATH THE FLOOR.



STRUCTURAL HARBORAGE. OPENINGS MADE IN FOUNDATION WALLS TO PERMIT PASSAGE OF PIPE LINES, ARE USED BY RATS TO GAIN ACCESS TO BUILDINGS.



STRUCTURAL HARBORAGE. THE HOLE GNAWED BY RATS IN THE CORNER OF THE BOXED-IN STEP GAVE THEM ACCESS TO THE HARBORAGE THEREIN ENCLOSED.



STRUCTURAL HARBORAGE. OUTSIDE DOOR SHOWING HOLES GNAWED BY RATS. THIS DOOR PREVIOUSLY HAD BEEN COVERED WITH A THIN METAL SHEATHING.



STRUCTURAL HARBORAGE. VULNERABLE SPOTS IN NONRATPROOFED DOORS AND DOOR FRAMES. HOLES GNAWED BY RATS IN THE BOTTOM OF THE DOOR, THE FRAMING OF WHICH WAS TWO OR THREE INCHES IN THICKNESS.



TEMPORARY HARBORAGE. EXAMPLE OF RAT HARBORAGE IN OLD RUBBISH AND DISCARDED MATERIAL STORED IN THE SECOND STORY OF A POULTRY MARKET.



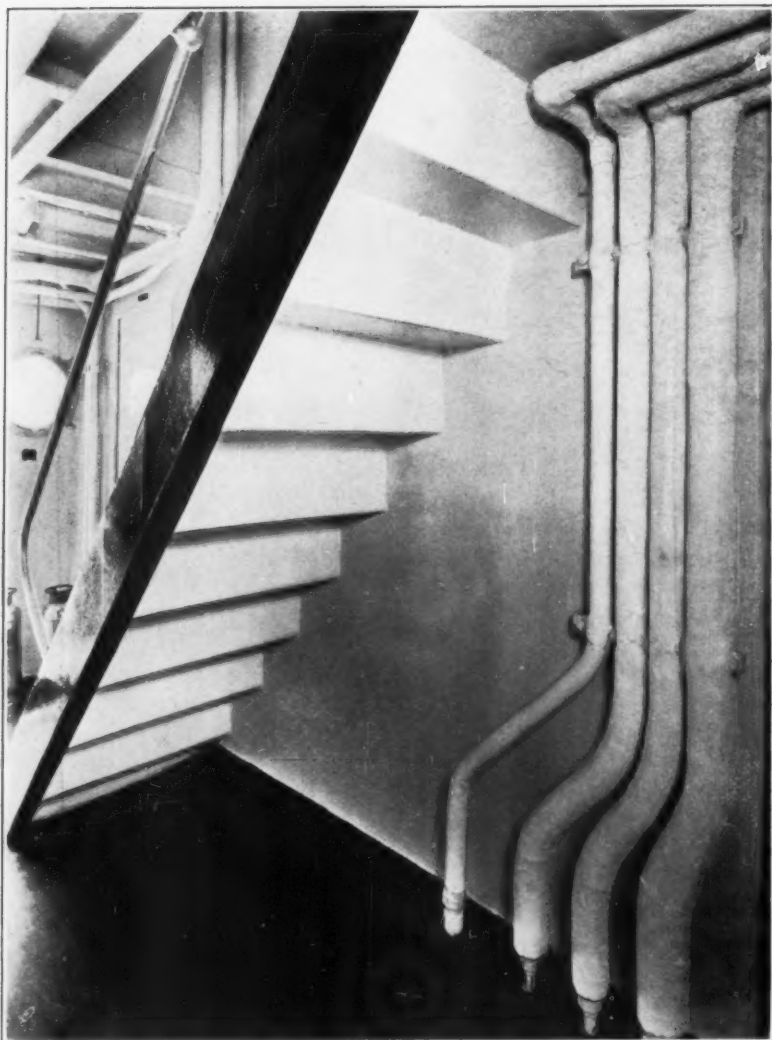
STRUCTURAL HARBORAGE. HOLE MADE BY RATS IN A SOFT BRICK WHICH WAS INSTALLED IN THE FOUNDATION WALL.



STRUCTURAL HARBORAGE. TYPICAL EXAMPLE OF HARBORAGE IN THE DOUBLE WALLS OF ENCLOSED STAIRWAYS. NOTE RAT HOLE.



STRUCTURAL HARBORAGE IN CELLARS. CARELESS METHODS AND DEFECTIVE WORKMANSHIP IN THE CONSTRUCTION OF FOUNDATION WALLS AND INSTALLATION OF FLOOR BEAMS HAS RESULTED IN THE CREATION OF RAT HARBORAGE.



RATPROOF TYPE OF STAIRWAY. A DESIGN WHICH IS FUNDAMENTALLY RATPROOF, ALL ENCLOSED SPACES HAVING BEEN ELIMINATED.



## APPENDIX

### PROPOSED DRAFT OF MODEL ORDINANCE REQUIRING THE RATPROOFING OF BUILDINGS AND OTHER STRUCTURES AND THE MAINTENANCE OF PERMANENT RAT CONTROL FOR THE PREVENTION OF ENDEMIC TYPHUS AND BUBONIC PLAGUE

Be it ordained, etc.

SECTION 1. That it shall be unlawful for any person, firm, or corporation hereafter to construct, repair, or remodel, including the installation of fixtures and equipment, any building, dwelling, out-house, stable, stall, market, or other structure whatsoever, unless such construction, repair, remodeling, or installation shall render the building or other structure ratproof in accordance with the regulations prescribed under section 2 of this ordinance: Provided, that only such repairs, remodeling, or installation as affect the ratproof condition of any building or other structure shall be considered as subject to the provisions of this ordinance. When a building or other structure shall have been ratproofed in accordance with the regulations prescribed under section 2 hereof, the owner shall, without a specific order by the \_\_\_\_\_ health officer and regardless of need for remodeling, repair, or installation, maintain such building or structure in a ratproof condition.

SEC. 2. The \_\_\_\_\_ health officer is authorized to prescribe and enforce regulations containing specifications covering designs which are inherently ratproof, the use of approved ratproof materials, the employment of standard ratproof methods of construction and installation, and such other matters as may be necessary to carry out the purposes of this ordinance. Until such regulations are prescribed, the latest model ratproofing specifications prepared by the United States Public Health Service<sup>1</sup> are made a part of this ordinance and shall have the same effect as regulations under this section.

SEC. 3. All plans for construction, repair, remodeling, or installation shall be submitted to the \_\_\_\_\_ health officer, who shall approve such plans in writing if he deems that they comply with the regulations prescribed under section 2 of this ordinance. No person, firm, or corporation shall proceed with any construction, repair, remodeling, or installation in the absence of written approval of the plans therefor by the \_\_\_\_\_ health officer in accordance with the provisions of this section.

SEC. 4. The \_\_\_\_\_ health officer is authorized to make inspection or to cause inspection to be made during the course of, and upon completion of, such construction, repair, remodeling, or installation, to insure compliance with the provisions of this ordinance and of the regulations prescribed hereunder. No person shall refuse to permit or interfere with such inspection.

SEC. 5. Where any violation of section 1, 3, or 4, or of the regulations prescribed under section 2 of this ordinance is occurring, or where there is reason to believe that such violation will occur, the \_\_\_\_\_ health officer is authorized to enter suit for an injunction, and the fact that a permit had been granted by the \_\_\_\_\_ for such construction, repair, remodeling, or installation shall not be considered as a defense. The \_\_\_\_\_ attorney shall represent the \_\_\_\_\_ health officer in such injunction proceeding.

<sup>1</sup> A copy of such model specifications for use in connection with the enactment of an ordinance will be furnished to any governmental agency upon request to the Surgeon General.—Ed.

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SEC. 6. Any violation of section 1, 3, or 4, or of the regulations prescribed under section 2, of this ordinance shall be punishable by a fine of not to exceed \_\_\_\_\_ or by imprisonment not to exceed \_\_\_\_\_ or by both such fine and imprisonment, in the discretion of the court.

SEC. 7. The \_\_\_\_\_ health officer is authorized to make or cause to be made \_\_\_\_\_ an inspection of existing buildings and other structures and  
(Annually, etc.)  
to order that any rat-infested building or other structure be ratproofed in accordance with the regulations prescribed under section 2 hereof, regardless of the need for the remodeling of, repairs to, or the installation of fixtures and equipment in such building or other structure. Any person who shall refuse to permit or shall interfere with such inspection, or any owner of a building or other structure who shall fail, within \_\_\_\_\_ months after the issuance thereof, to comply with an order to ratproof a building or structure issued under this section, shall be fined not to exceed \_\_\_\_\_ or imprisoned not to exceed \_\_\_\_\_ or be both fined and imprisoned, in the discretion of the court. Every month during which any such owner shall fail to comply with such an order shall constitute a separate offense.

**TYPHUS FEVER CONTROL MEASURES—SURVEY OF BUILDINGS AND EQUIPMENT  
TO OBTAIN INFORMATION AS TO EXISTENCE, CHARACTER, LOCATION OF RAT  
HARBORAGE, AND EXTENT OF RAT INFESTATION**

OFFICE OF DIRECTOR OF ..... HEALTH UNIT

City ..... Date ..... No. ....  
Street and house number ..... Type of building inspected ..... Used as ..... Name and address of owner ..... Name of present tenant .....

**INFORMATION AS TO BUILDING**

1. Material of which constructed: Brick Concrete Frame Galv. Iron Sheets Other No
2. Type of foundation walls ..... Do they extend 3 feet below surface? Yes No
3. Is there a cellar? Yes No
4. If so, has it a floor that is ratproof? Yes No Describe same .....
5. Are the foundation walls plastered smooth, all crevices filled in, and all harborage eliminated? Yes No
6. Are all outside openings into cellar properly protected in accordance with the ratproof standard methods? Yes No
7. Is the cellar or space beneath this building kept free from accumulated trash, junk, or old supplies? Yes No
8. Is the under side of the floor rafters sheathed, forming an enclosed space? Yes No
9. Are all openings around sewer, water, gas, electric lines, etc., which pass from the cellar or underneath space into the upper floors protected and ratproofed so that rats cannot pass through them? Yes No
10. Are there openings around the stud spaces through which rats can pass or have these spaces been properly filled in and ratproofed? Describe .....
11. What kind of a cellar door is there? Is it properly protected so that rats cannot gain entrance? Yes No
12. Describe the character and number of doors and windows or other natural openings existing in this building .....
13. Do they fit snugly in the frames and are they made of ratproof material or protected at all gnawing points with galv. iron sheet metal so as to make them ratproof? Yes No
14. Are doorsills provided for the outside doors so as to block out the underneath space? .....
15. Do the screens on windows or doors extend to the edges of wooden frames? Yes No  
Are they securely bordered with metal strips and securely anchored so as to prevent edges from becoming loose? Yes No
16. Have all openings that were made in the outside walls for the purpose of bringing in pipe lines, telephone cables, electric light feed lines, etc., been properly closed? Yes No
17. Are the spaces between the roof joists or studs filled in with antignawing material installed in such a ratproof manner as to make rat invasion impossible? Yes No
18. Are skylights, roof ventilators, or other openings into the roof space or attic protected in such a manner as to make rat invasion impossible? Yes No
19. Are the walls of the building itself single or double; that is, are there enclosed spaces above the cellar or main floor? .....
20. Are the underneath sides of the ceiling rafters sheathed so as to form enclosed spaces? Yes No
21. Are the under sides of stairways sheathed and enclosed? Yes No
22. What kind of material is used for such sheathing? .....
23. Are there openings around all pipe lines, cable lines passing through such sheathing or partitions? If so, has any attempt been made to install metal collars around them? .....
24. Are there any raised floors in the toilets or other parts of the buildings which have hollow spaces beneath them? Yes No Give location .....
25. Are there any double walls or hollow type partitions (such as are in use in cafes) in this building? Yes No Any boxed-in columns around structural beams? Yes No
26. What type of wainscoting is installed and what kind of material has been used? .....
- Is the bottom edge protected by a ratproof molding or metal strip? .....
27. If a concrete floor has been installed has it been built and tied into the structural outside walls and does it present an unbroken line of union at the floor level? Yes No

**FINDINGS AS TO HARBORAGE AND ACTUAL INFESTATION BY RATS**

28. Upon inspection and survey of the building above described I found uncorrected rat harborage existing in the structure itself as indicated by the answers to the above questionnaire, especially in the following places:  
.....  
.....  
.....
29. Rat harborage was discovered also in the fixtures and equipment installed in this building as indicated on the attached report of the ratproof status of fixtures.
30. The ratproofing or the elimination or correction of harborage in both the building and its equipment is indicated in the attached report (see sample copy) which has been transmitted to the occupant of the building.
31. Actual rat infestation was found to exist in the following-named places:  
.....  
.....  
.....

Sanitary officer or inspector.

# RATPROOF STATUS OF FIXTURES AND EQUIPMENT INSTALLED IN BUILDINGS

OFFICE OF DIRECTOR OF \_\_\_\_\_ HEALTH UNIT

City (or) County of \_\_\_\_\_ Date \_\_\_\_\_

No. \_\_\_\_\_

Street and  
House number

Name of owner  
or tenant

Name and address  
of owner

Character of business  
carried on in building

Kind of fixture	Class of material of which made	Ratproof or non- ratproof con- struction	How install- ed, rat- proof or not	Description of type of harborage, if present
1. Counters.....	Metal <input type="checkbox"/> Wood <input type="checkbox"/>	Ratproof <input type="checkbox"/>		Space at bottom <input type="checkbox"/> Space behind <input type="checkbox"/>
	Other <input type="checkbox"/>	Nonratproof <input type="checkbox"/>		On top <input type="checkbox"/> In fixture <input type="checkbox"/>
2. Shelves.....	Metal <input type="checkbox"/> Wood <input type="checkbox"/>	Ratproof <input type="checkbox"/>		Space at bottom <input type="checkbox"/> Space behind <input type="checkbox"/>
	Other <input type="checkbox"/>	Nonratproof <input type="checkbox"/>		On top <input type="checkbox"/> In fixture <input type="checkbox"/>
3. Bins.....	Metal <input type="checkbox"/> Wood <input type="checkbox"/>	Ratproof <input type="checkbox"/>		Space at bottom <input type="checkbox"/> Space behind <input type="checkbox"/>
	Other <input type="checkbox"/>	Nonratproof <input type="checkbox"/>		On top <input type="checkbox"/> In fixture <input type="checkbox"/>
4. Lockers.....	Metal <input type="checkbox"/> Wood <input type="checkbox"/>	Ratproof <input type="checkbox"/>		Space at bottom <input type="checkbox"/> Space behind <input type="checkbox"/>
	Other <input type="checkbox"/>	Nonratproof <input type="checkbox"/>		On top <input type="checkbox"/> In fixture <input type="checkbox"/>
5. Showcases.....	Metal <input type="checkbox"/> Wood <input type="checkbox"/>	Ratproof <input type="checkbox"/>		Space at bottom <input type="checkbox"/> Space behind <input type="checkbox"/>
	Other <input type="checkbox"/>	Nonratproof <input type="checkbox"/>		On top <input type="checkbox"/> In fixture <input type="checkbox"/>
6. Desks.....	Metal <input type="checkbox"/> Wood <input type="checkbox"/>	Ratproof <input type="checkbox"/>		Space at bottom <input type="checkbox"/> Space behind <input type="checkbox"/>
	Other <input type="checkbox"/>	Nonratproof <input type="checkbox"/>		On top <input type="checkbox"/> In fixture <input type="checkbox"/>
7. File cases.....	Metal <input type="checkbox"/> Wood <input type="checkbox"/>	Ratproof <input type="checkbox"/>		Space at bottom <input type="checkbox"/> Space behind <input type="checkbox"/>
	Other <input type="checkbox"/>	Nonratproof <input type="checkbox"/>		On top <input type="checkbox"/> In fixture <input type="checkbox"/>
8. Cupboards.....	Metal <input type="checkbox"/> Wood <input type="checkbox"/>	Ratproof <input type="checkbox"/>		Space at bottom <input type="checkbox"/> Space behind <input type="checkbox"/>
	Other <input type="checkbox"/>	Nonratproof <input type="checkbox"/>		On top <input type="checkbox"/> In fixture <input type="checkbox"/>
9. Pantry lockers.....	Metal <input type="checkbox"/> Wood <input type="checkbox"/>	Ratproof <input type="checkbox"/>		Space at bottom <input type="checkbox"/> Space behind <input type="checkbox"/>
	Other <input type="checkbox"/>	Nonratproof <input type="checkbox"/>		On top <input type="checkbox"/> In fixture <input type="checkbox"/>
10. Work tables.....	Metal <input type="checkbox"/> Wood <input type="checkbox"/>	Ratproof <input type="checkbox"/>		Space at bottom <input type="checkbox"/> Space behind <input type="checkbox"/>
	Other <input type="checkbox"/>	Nonratproof <input type="checkbox"/>		On top <input type="checkbox"/> In fixture <input type="checkbox"/>
11. Ice boxes.....	Metal <input type="checkbox"/> Wood <input type="checkbox"/>	Ratproof <input type="checkbox"/>		Space at bottom <input type="checkbox"/> Space behind <input type="checkbox"/>
	Other <input type="checkbox"/>	Nonratproof <input type="checkbox"/>		On top <input type="checkbox"/> In fixture <input type="checkbox"/>
12. Refrigerators.....	Metal <input type="checkbox"/> Wood <input type="checkbox"/>	Ratproof <input type="checkbox"/>		Space at bottom <input type="checkbox"/> Space behind <input type="checkbox"/>
	Other <input type="checkbox"/>	Nonratproof <input type="checkbox"/>		On top <input type="checkbox"/> In fixture <input type="checkbox"/>
13. Stoves or ranges.....	Metal <input type="checkbox"/> Wood <input type="checkbox"/>	Ratproof <input type="checkbox"/>		Space at bottom <input type="checkbox"/> Space behind <input type="checkbox"/>
	Other <input type="checkbox"/>	Nonratproof <input type="checkbox"/>		On top <input type="checkbox"/> In fixture <input type="checkbox"/>
14. Steam tables.....	Metal <input type="checkbox"/> Wood <input type="checkbox"/>	Ratproof <input type="checkbox"/>		Space at bottom <input type="checkbox"/> Space behind <input type="checkbox"/>
	Other <input type="checkbox"/>	Nonratproof <input type="checkbox"/>		On top <input type="checkbox"/> In fixture <input type="checkbox"/>
15. Ventilating trunks.....	Metal <input type="checkbox"/> Wood <input type="checkbox"/>	Ratproof <input type="checkbox"/>		Space at bottom <input type="checkbox"/> Space behind <input type="checkbox"/>
	Other <input type="checkbox"/>	Nonratproof <input type="checkbox"/>		On top <input type="checkbox"/> In fixture <input type="checkbox"/>
16. Floor gratings.....	Metal <input type="checkbox"/> Wood <input type="checkbox"/>	Ratproof <input type="checkbox"/>		Space at bottom <input type="checkbox"/> Space behind <input type="checkbox"/>
	Other <input type="checkbox"/>	Nonratproof <input type="checkbox"/>		On top <input type="checkbox"/> In fixture <input type="checkbox"/>
17. Kitchen sinks.....	Metal <input type="checkbox"/> Wood <input type="checkbox"/>	Ratproof <input type="checkbox"/>		Space at bottom <input type="checkbox"/> Space behind <input type="checkbox"/>
	Other <input type="checkbox"/>	Nonratproof <input type="checkbox"/>		On top <input type="checkbox"/> In fixture <input type="checkbox"/>
18. ....	Metal <input type="checkbox"/> Wood <input type="checkbox"/>	Ratproof <input type="checkbox"/>		Space at bottom <input type="checkbox"/> Space behind <input type="checkbox"/>
	Other <input type="checkbox"/>	Nonratproof <input type="checkbox"/>		On top <input type="checkbox"/> In fixture <input type="checkbox"/>
19. ....	Metal <input type="checkbox"/> Wood <input type="checkbox"/>	Ratproof <input type="checkbox"/>		Space at bottom <input type="checkbox"/> Space behind <input type="checkbox"/>
	Other <input type="checkbox"/>	Nonratproof <input type="checkbox"/>		On top <input type="checkbox"/> In fixture <input type="checkbox"/>

Describe below any unusual conditions as to harborage found.  
Also indicate the type and extent of corrective measures (ratproofing) recommended.

.....  
.....  
.....

Name  
(Title).....

Date: .....

## ACKNOWLEDGMENTS

Tribute is gratefully paid to the value of the splendid work done by a number of officers of the Public Health Service in connection with the early development of the ratproofing of buildings as a plague-control measure. Their contribution to this cause and their accomplishments have served both as an inspiration and a guide in the preparation of this publication. Acknowledgment is especially made to the following officers, with whom it has been my good fortune to serve during the prevalence of actual epidemics: Medical Director S. B. Grubbs, Medical Director R. H. Creel, and Assistant Surgeon General C. L. Williams, and to some of the pioneers in this work, viz, former Surgeon General Rupert Blue, Medical Directors Fiench Simpson, Carroll Fox, G. W. McCoy, Mark J. White, W. C. Rucker, Senior Surgeons F. A. Carmelia and C. V. Akin.

Considerable work has been done by the personnel of the Bureau of Biological Survey, United States Department of Agriculture, in connection with the ratproofing of buildings, principally those on farms. While their objective has been the reduction of economic losses the methods suggested by them and as published in the various pamphlets issued by that Bureau are more or less identical with those which have been employed by the Public Health Service.

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